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PALEONTOLOGY.—*The classification of the strophomenoid brachiopods.* Alwyn Williams, Glasgow University. (Communicated by G. A. Cooper.)

The strophomenoid brachiopods include a host of diversified stocks that flourished mainly during Paleozoic times, although a descendant, the thecideid *Lacazella*, still survives. The morphological variation of the group is extremely wide, as a comparison of such bizarre forms as *Gemmellaroia*, *Leangella*, *Scacchinella*, *Stropheodonta*, *Thecospira*, and *Taffia* shows. Nevertheless, there are a number of morphological features that may be regarded as typically strophomenoid; they include the pseudopunctate condition of the test, the shell modification due to the loss of a functional pedicle, the presence of a pseudodeltidium and chilidium, the nature of the cardinal process and the absence of brachiophores, and shell convexity.

The pseudopunctae represent long, unbranched, arcuate calcareous rods embedded within the fibrous layer of the shell (Fig. 1). They do not penetrate the lamellar layer, and it is supposed that they were laid down by the outer epithelial layer of the mantle immediately behind the outer lobe. It is probable that the deposition and growth of these spicules were limited mainly to the mantle proper, for in the postero-median portion of the adult shell, an area presumed to have been occupied by the viscera, an inner impunctate fibrous layer generally extends over a pseudopunctate zone laid down during the early stages of shell growth. In addition, the structures grouped around the notothyrium—the cardinal process, socket ridges, and notothyrial platform—are impunctate, as are also the teeth and supporting lamellae of the pedicle valve; although in the stropheodontids, which had a series of denticles arranged along the hinge-line in place of simple teeth each denticle is built of fibrous material deposited around a rod of nonfibrous calcite similar to the pseudopunctae. The chilidium and pseudodeltidium are also impunctate, being composed principally of an extension of the lamellar layer sometimes supported by an underlying deposit of fibrous calcite. Beecher (1901), p. 260) cited the impunctate nature of the pseudodeltidium as evidence to support his contention that the pseudodeltidium represents a third shell subsequently fused to the pedicle valve in contrast to the punctate deltidium, which he regarded as an integral part of the pedicle valve, in punctate telotrematous forms. In this respect at least his observations are incorrect: the pseudodeltidium is impunctate because it is composed of the lamellar layer which is not perforated in any strophomenoids, whereas the deltidium of such a form as a terebratuloid is punctate because both fibrous and lamellar layers of the shell are penetrated by the caecae.

It has long been known that in the post-nepionic stages of the majority of strophomenoids a functional pedicle was absent and that consequently the mode of life varied from lying free on the sea floor to attachment either by the pedicle or by cementation of the pedicle valve to some foreign body. The persistence of a functional pedicle throughout life is more characteristic of the earlier strophomenoids for, despite exceptions like *Leptaena*, most of the later Lower Paleozoic stocks were not attached. Attachment by cementation of the pedicle valve was a later development attained by many independent groups but especially characteristic of the Upper Paleozoic orthotetaceids.

The position of the pedicle in relation to the valves is a highly distinctive feature of the strophomenoids. In the young stages of unattached stocks like *Sowerbyella*, *Fardenia*, and *Strophomena*, as well as in forms with a persistently functional pedicle like *Leptaena*, the pedicle base was ensheathed in a pipe consisting of an extension of the lamellar layer situated on the apex of the umbo and not on any part of the interarea of the pedicle valve. This pedicle sheath then was distinct from the pseudodeltidium or delthyrium as can be seen in adult forms with the scar of the pedicle sheath still visible, though in some strophomenoids with a persistent pedicle the foramen was frequently enlarged by resorption and encroached on to the apex of the pseudodeltidium.

The disposition of the pedicle sheath represents a radical departure from the telotrematous pedicle opening which is limited to the delthyrium. Also if Percival's observation (1945) on *Terebratella inconspicua* Sowerby—that the pedicle valve occupies a dorsal position during development—had general application the position of the pedicle foramen has an added significance, for the inclination of the sheath away from the hinge-line suggests that in this group the converse was true.

The limitation of the pedicle opening to the apex of the pedicle valve and not to the interarea probably accounted for the complementary growth of the pseudodeltidium and chilidium: the latter structure is an integral part of the brachial valve yet it fits snugly with the edge of the former and its size is inversely proportional to the development of the pseudodeltidium. In this way the median openings of the interareas which in other brachiopods accommodated the pedicle were effectively sealed by the mantle flaps which were also responsible for the growth of the interareas. This complementary growth of the pseudodeltidium and chilidium was expressed in the more advanced stocks such as the stropheodontids and orthotetaceids in a trend toward the complete elimination of the chilidium and the development of an entire pseudodeltidium flush with the hinge-line. This ultimate stage was reached independently by many Devonian stropheodontids but only by one orthotetaceid, the Triassic *Thecospira*, for even in the Permian forms like *Meekella* and *Derbyia* a vestige of the chilidium remained and the pseudodeltidium carried a narrow median fold which accommodated it. Nevertheless, despite such a trend and its culmination in the stropheodontids and *Thecospira* it is true to say that both structures are typical features of strophomenoid organization.

The development of two distinctive types of cardinal processes is also highly significant in the strophomenoids.

In a number of early stocks like *Taffia* and *Leptella* the diductor scars must have been attached directly to the floor of the notothyrium for there are no outgrowths which could have accommodated the muscle bases.

The most primitive modification of this state was the growth of a median partition which usually extended from the notothyrial floor to the chilidium as in the plectambonitids. This septum is commonly described as a simple cardinal process and the continued usage of this term is eminently convenient but in all probability the diductor bases were attached to the notothyrial floor on either side of the median septum or to a pair of small lateral ridges.

A similar development occurred in the leptestiids. Thus some early members like *Leptella* were without a median partition while some later stocks like *Leangella* were equipped with a series of lateral ridges in addition to the median septum. The leptestiids were characterized especially by the development of a pair of prominent plates—the chilidial plates—forming the lateral walls of the notothyrium. These together with the median septum were not only firmly ankylosed to the notothyrial floor but also elevated above the hinge-line and prolonged ventrally to it and since the muscle bases were probably inserted within the slots formed by the median septum and the chilidial plates the entire structure is analogous to the bilobed cardinal process.

The bilobed cardinal process of the strophomenaceids and orthotetaceids is quite distinct from the plectambonitaceid arrangement for the diductor muscles were attached not to the notothyrial floor but to a pair of outgrowths from it, each of which bore the muscle bases on the posterior face, the area of attachment being often increased by the growth of numerous thin calcareous plates. Öpik (1932, p. 61) has commented on the presence of a fine ridge lying medianly between the lobes of the cardinal process of many strophomenaceids and his suggestion that this ridge is a degenerate homologue of the plectambonaceid median partition is probably true.

Despite subsequent modification of the strophomenaceid cardinal process, as for example the stropheodontids and orthotetaceids in which the chilidium and notothyrium are vestigial or absent and the cardinal process lobes project for some distance into the umbonal region of the pedicle valve, the pattern of development outlined above seems to be fundamental.

Another important feature of strophomenoid organization was the apparent, and in many stocks the undoubted, absence of

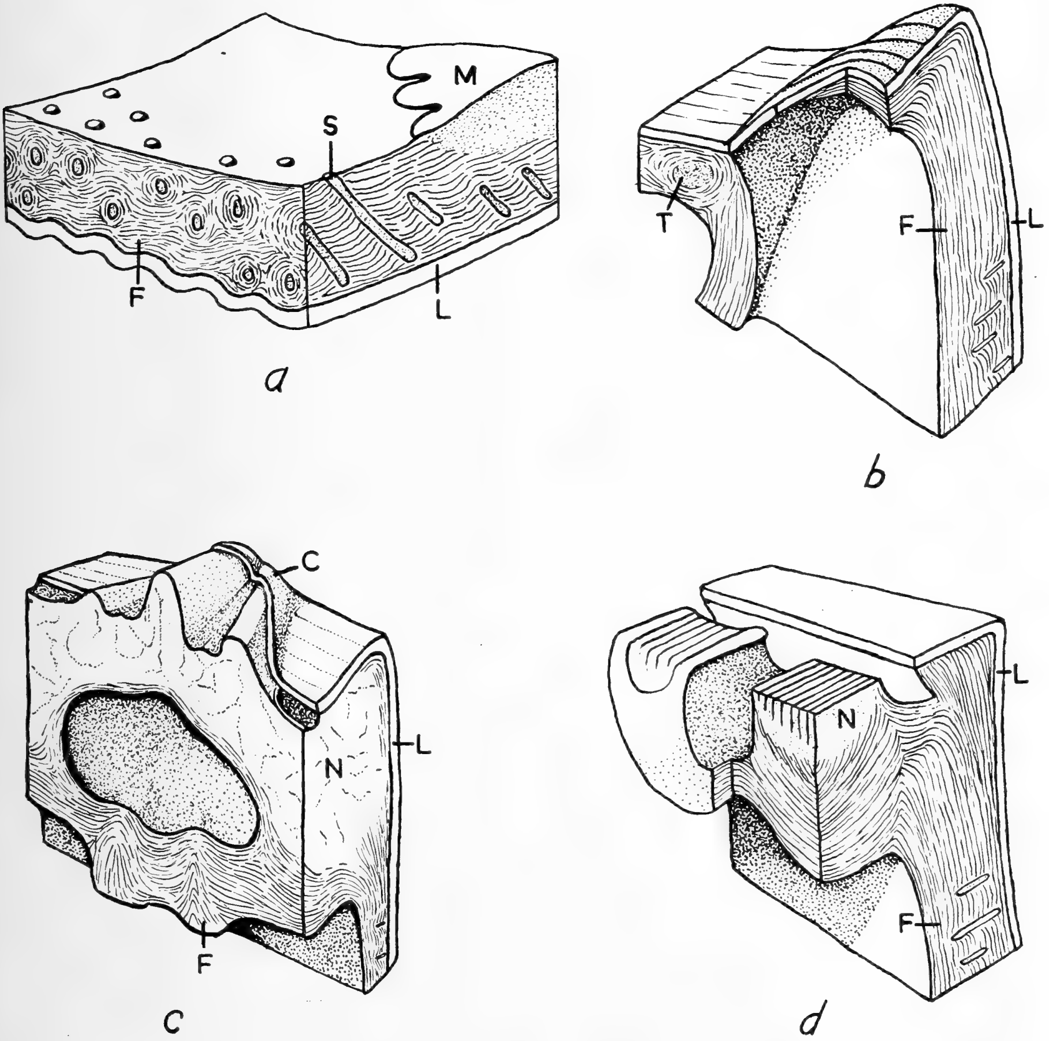


FIG. 1.—Strophomenoid shell structure: A, Diagrammatic representation of a portion of a strophomenoid valve just anterior to the muscle scar showing the lamellar layer (L), the spicules (S) embedded in the fibrous layer (F), and the nonfibrous calcareous deposit of the muscle base (M); B, structure of the strophomenoid pseudodeltidium showing the lamellar layer (L), the fibrous layer (F), and a section of a tooth (T); C and D, the plectambonaceid and strophomenaceid cardinal processes, as typified by *Sowerbyella* and *Strophonelloides*, respectively; chilidium (C), lamellar layer (L), fibrous layer (F), and calcareous nonfibrous deposit (N).

any specialized structures associated with the cardinalia which gave support to the lophophore. Thus in the stropheodontids the pair of ridges forming the inner boundary of the sockets in early members are usually referred to as "brachiophores." With the progressive spread of denticles along the hinge line in later stocks, the teeth and socket arrangement became vestigial and the ridges either disappear entirely or, exceptionally as in the Leptostrophias, became modified to form ankylosed buttresses to the cardinal process lobes. It seems then that the ridges were nothing more than internal walls to the sockets, and the function of lophophore support cannot be ascribed to them. This is equally true for the strophomenids which are equipped with weak ridges like the early stropheodontids.

Within the orthotetaceid group there is also no evidence to suggest that any specialized structures supported the lophophore; the presence of strong, large teeth, the loss of the interarea of the convex brachial valve, and the pronounced ventral growth of the bilobed cardinal process all contributed to the development of a pair of highly modified socket ridges which usually formed concave cups ankylosed to the sides of the cardinal process lobes and supported by a pair of plates growing up from the floor of the valve, e.g., *Meekella*. Even in *Thecospira* the calcareous spires were not attached to any structures associated with the socket ridges but were supported by a pair of very short, scarcely differentiated outgrowths from the bases of the cardinal process lobes.

Öpik (1933, p. 44) has come to a similar conclusion in his investigation of *Leangella* in which the ridges defining the teeth sockets are especially prominent; and in the plectambonaceids generally it is highly likely that the so-called "crural processes" or "brachiophores" functioned only as socket bounding ridges. It is therefore suggested that the term "socket ridge" be used in place of "crura" or "brachiophores" for all strophomenoids.

There is not very much evidence as to the form of the strophomenaceid lophophore but from a knowledge of occasionally preserved impressions as in *Leptaenisca* and *"Strophomena" jukesi* Davidson it is probable that it consisted of a pair of depressed spiral coils, a disposition compatible with shell configuration.

A spirolophous lophophore was apparently also characteristic of the orthotetaceids; impressions of depressed coiled brachia are found in *Davidsonia* and in *Thecospira*, a form hitherto classified as a rostrospiraceid, the fleshy brachia were strengthened by the development of a pair of spirally coiled calcareous ribbons. These spires form a pair of high cones extending well into the interior of the pedicle valve and it is probable that the lophophore of those orthotetaceids in which the depth of the shell was greatly increased by the exceptional growth of the pedicle valve were similarly disposed.

On the other hand many paleontologists, notably Kozlowski (1929) and Öpik (1933), have concluded that the strongly elevated and striated ridge often found in the plectambonaceid brachial valve completely surrounding the postero-median area (here called the "lophophore platform") represent the zone of attachment for the lophophore in a manner analogous to the lophophore-supporting structure of thecideids. The suggestion is certainly the most plausible explanation for the development of such an extraordinary feature and if it is correct the lophophore probably consisted of a simple lobate ring (compare the ptycholophous condition as in *Lacazella*).

Elevated ridges are also found in the brachial valve of the strophomenaceid *Christiania* and are strongly reminiscent of the plectambonaceid lophophore platform. In this stock however the partitions are disposed in two discrete loops and if the functional interpretation of these structures is correct the lophophore was schizolophous.

One other important characteristic remains to be discussed—namely, the configuration of the shell. The protegulum and nepionic shells of all strophomenoids, as far as known, were biconvex, a relationship that was maintained throughout the ontogeny of the orthotetaceids except for a minority like some schellwienellas in which the pedicle valve became concave during ephebic stages of growth.

The brachial valve of all strophomenaceids and plectambonaceids in contrast became concave in neanic stages at least and although many independent stocks develop resupinate shells the concavo-convex relationship of the neanic stage was never completely eliminated.

This contrast between the biconvex shell of the orthotetaceids and what is essentially a simple or modified concavo-convex shell of the plectambonaceids and strophomenaceids was probably accompanied by important differences in anatomical distribution and constituted a significant divergence within the group.

THE BASIS OF CLASSIFICATION

Until the publication of Öpik's brachiopod studies (1930–1934) the classification of the strophomenoids had never been in a satisfactory state although their distinctiveness had been apparent to paleontologists since 1848 when King took what was then a radical step and erected a family, the Strophomenidae, for the inclusion of *Strophomena* and allied forms. Even the historic studies of Beecher did little to stimulate any worthwhile suprageneric grouping and as recently as 1929 Schuchert and Le Vene (p. 16) described the classification of the strophomenoids as "not yet satisfactory" and were content to use resupination as a subfamily division of the Strophomenidae though they must have been aware of the artificiality of such an arrangement.

The plectambonaceid classification proposed by Öpik is preeminently utilitarian; it consists of the grouping together of demonstrably related genera into subfamilies, families, etc., by purely morphological comparisons: but because it is executed with all due regard to the range of individual stocks it transcends the pigeonholing of genera and allows for the establishment of as natural a classification as one can expect in the light of present knowledge.

The building up of a classification from a series of basic units in this way reveals a number of important features concerning the morphogeny of a series of related stocks. It is for instance usual to find that very few, if any, characters are peculiar to a group; many characters, often the most diagnostic ones, appear independently in other remotely related stocks and it appears that the higher the suprageneric category the greater the morphological overlap with other categories.

Thus superfamily definitions of plectambonitaceids and the orthoid clitambonaceids classified in this way are virtually the same although nobody acquainted with the groups would hesitate to agree that they were independent of each other from inception to extinction.

This continual reduplication of morphological features in undoubtedly independent groups is of course related to the mechanics of evolution. It is an expression of parallelism in related stocks and though it raises many taxonomic problems it cannot be ignored. This realization should allay most doubts arising from a classification in which it is sometimes impossible to describe a series of characters which are unique to one category or another.

Another fact emerging from the building up of a classification by the grouping together of related genera is that any morphological features will generally have a taxonomic importance directly related to the number of independent lines of descent (expressed systematically as genera) constituting a stock and not a preconceived value constant throughout a series of stocks. For example, the type of cardinal process is taxonomically one of the most important strophomenoid characters. Along with other features it serves to distinguish the plectambonitaceids from the strophomenaceids and in this instance has a superfamily status. In contrast, the absence of a cardinal process in the taffiids and leptestiids serves only to distinguish genera although had such primitive stocks undergone persistent divergences and specialization unaccompanied by the development of a cardinal process its absence would have been correspondingly more important taxonomically.

This is true for instance of the orthotetaceids. The orthotetaceids were equipped with a bilobed cardinal process homologous with the strophomenaceid one, and on the basis of this structure alone would be included within the strophomenaceids. But the orthotetaceid stock, which was distinct in such features as the persistence of a biconvex shell throughout ontogeny and the almost universal adoption of the cementing habit, survived into the Trias and during its existence underwent a number of significant divergences some of which merit family recognition, thus imparting to the stock a superfamily status. Accordingly the bilobed cardinal process being present in all members of the Strophomenacea and Orthotetacea has a subordinal value.

This pattern of variable taxonomic values for the cardinal process is true for all characters and is a natural manifestation of divergence and development.

The classification proposed below has been modelled with the foregoing considerations in mind. Its basic units—the generic stocks—have been grouped together into appropriate suprageneric categories and the only factor other than morphological comparison which has been given particular attention is the time range of each genus, in the hope that the more blatant deficiencies of morphological grouping will be eliminated.

Suborder STROPHOMENOIDEA Öpik, 1934, emended

Brachiopods derived out of orthoid ancestors by the development of a pseudopunctate shell and by the early loss of a functional pedicle so that the majority of forms included in the suborder either lay free on the sea floor or were attached by cementation to a foreign body; delthyrium and notothyrium closed posteriorly by the complementary development of a pseudodeltidium and chilidium; diductor bases of the branchial valve attached to a bilobed cardinal process or to the notothyrial floor variously modified and usually divided into two distinct areas by a median "cardianal process"; lophophore, unsupported by any specialized part of the cardinalia but in some stocks presumably attached to a platform developed on the brachial valve and exceptionally strengthened by a calcareous skeleton, generally spirolophous, sometimes ptycholophous, exceptionally schizolophous. Lower Ordovician to Recent.

PLECTAMBONACEA, n. superfamily

Concavo-convex or resupinate strophomenoids with cardinalia consisting of well developed socket ridges, a notothyrium covered by a convex chilidium sometimes supported, and exceptionally replaced, by a pair of chilidial plates, and a cardinal process, which when present, consists of a simple median ridge with subsidiary lateral ridges in later forms; pseudodeltidium small, pedicle presumably functional in those adult forms with a persistent supra-apical foramen, more usually lost during ontogeny so that mature shells of most stocks were unattached. Ordovician to Devonian.

Family Taffiidae Ulrich and Cooper, 1936

Plectambonaceids with orthoidlike musculature and cardinalia; notothyrium covered completely by a convex chilidium, cardinal process when present, simple, median supra-apical foramen small, persistent throughout ontogeny. Lower Ordovician, Upper Canadian to Chazy. Type genus, *Taffia* Ulrich.

Family Plectambonitidae Kozlowski, 1929

Plectambonaceids with a median cardinal process growing from the notothyrial floor and ankylosed posteriorly to a convex chilidium; pedicle valve with a pair of accessory teeth lying anterolaterally to two simple teeth; brachial valve with a variably developed lophophore platform; supra-apical foramen sporadically persistent in adult forms. Lower and Middle Ordovician.

Subfamily Plectambonitinae Jones, 1928

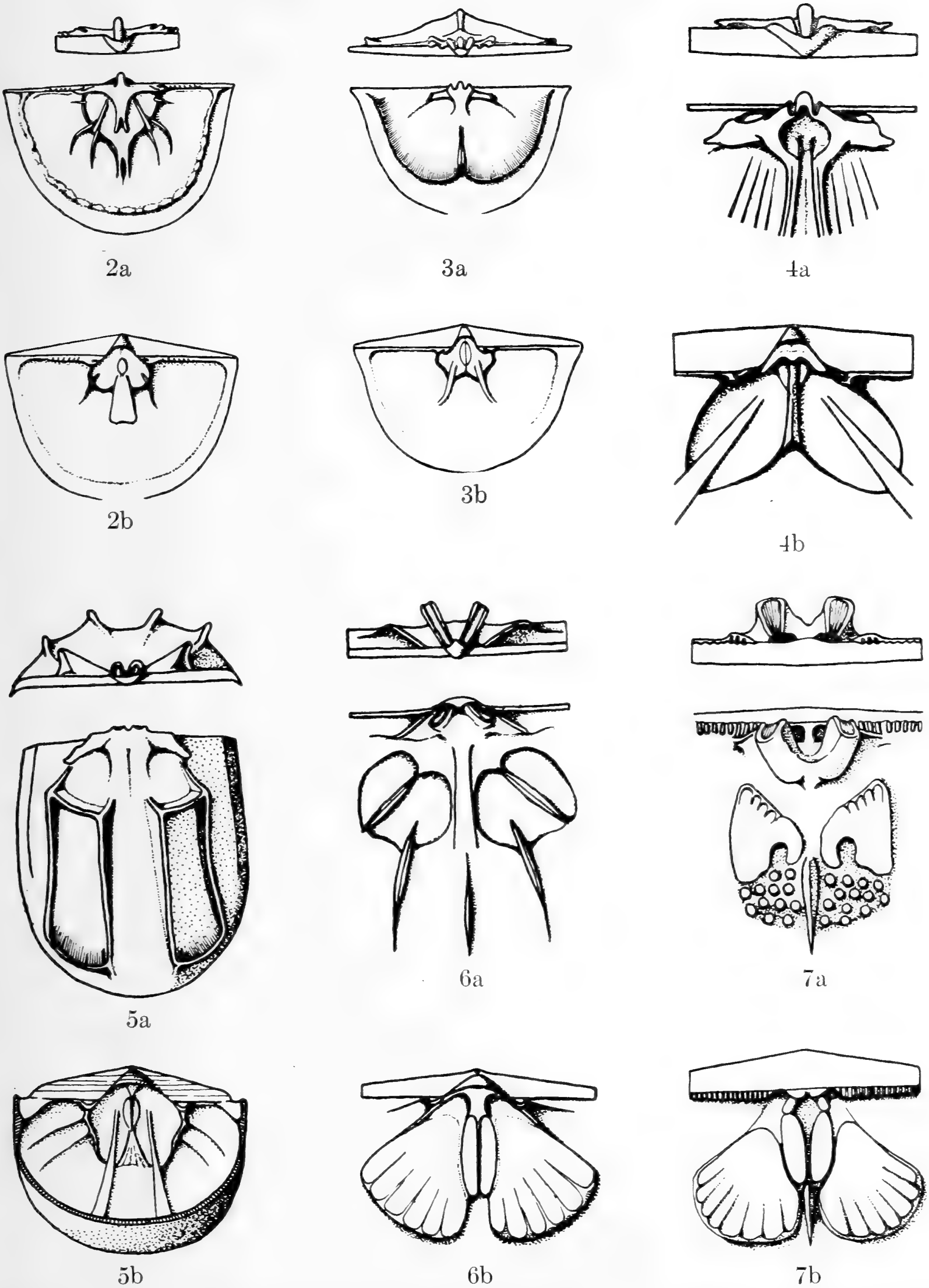
Plectambonitids with a denticulate hinge line in addition to the accessory and simple teeth; pedicle valve with divergent diductor scars separated anteriorly by a low broad plate; brachial valve with aseptate muscle scars. Lower and Middle Ordovician (B_2 to C_3 of the Baltic.) Type genus, *Plectambonites* Pander.

Subfamily Ahtiellinae Öpik, 1933

Plectambonitids with smooth hinge lines and a lophophore platform developed on the brachial valve. Lower Ordovician (B_3 to C_1 of the Baltic.) Type genus, *Ahtiella* Öpik.

Leptestiidae, n. family

Plectambonaceids with a pair of chilidial plates usually supporting a chilidium forming the sides of the notothyrium and generally ankylosed to the median cardinal process to form a tripartite structure; brachial valve usually provided with an elevated lophophore platform. Lower Ordovician to Middle Devonian.



Figs. 2–7.—2, Plectambonitid morphology, *Ingria* Opik; interior of brachial valve (2a) with posterior view above; interior of pedicle valve (2b). 3, Leptestiinid morphology, *Leptellina* Ulrich and Cooper; interior of brachial valve (3a) with posterior view above; interior of pedicle valve (3b). 4, Sowerbyellinid morphology as typified by *Sowerbyella* Jones; cardinalia of brachial valve (4a) with posterior view above, posteromedian area of pedicle valve (4b). 5, Christianiid morphology as typified by *Christiania* Hall and Clarke; interior of brachial valve (5a) with posterior view above, interior of pedicle valve (5b) with the anterior part of the shell removed to show the posteromedian area. 6, Generalized strophomeninid morphology; cardinalia and muscle scars of brachial valve (6a) with posterior view above, posteromedian area of pedicle valve interior (6b). 7, Stropheodontid morphology, *Strophonelloides* Caster; cardinalia and muscle scars of brachial valve (7a) with posterior view above, posteromedian area of pedicle valve interior (7b).

Subfamily Leptestiinae Öpik, 1933

Leptestiids with the socket ridges not fused with the chilidial plates and with a strongly developed lophophore platform; median cardinal process occasionally absent, in some later stocks flanked by two or more subsidiary ridges; adductor scars of brachial valve sometimes borne on an elevated platform lying anterior to the cardinalia; accessory teeth and denticulate hinge-line occasionally developed; supraapical foramen never persistent throughout ontogeny. Lower Ordovician (Upper Canadian) to Upper Silurian. Type genus, *Leptestia* Bekker.

Subfamily Sowerbyellinae Öpik, 1930

Leptestiids with the chilidial plates, median cardinal process, and socket ridges ankylosed to the notothyrial platform to give a structure like an inverted V; hinge line exceptionally denticulate or pierced by oblique canals; apical foramen rarely persistent throughout ontogeny. Ordovician to Middle Devonian. Type genus, *Sowerbyella* Jones.

Discussion.—The leptestiinids and the sowerbyellinids were from their inception quite distinct from contemporary plectambonaceids especially in the development of the chilidial plates and it seems that the two groups represented an important divergent development from the strophomenoid ancestral stocks.

Ulrich and Cooper (1936, p. 626) erected a subfamily, the Leptellinae, for the inclusion of early forms like *Leptellina* and *Leptella* which had either a simple cardinal process or none at all. In the opinion of the writer the subfamily is best regarded as a synonym of the Leptestiinae Öpik, 1933; many European leptestiinids also possess a simple median cardinal process and its absence in *Leptella* was, as Ulrich and Cooper demonstrated for the taffiids, not particularly significant among primitive plectambonaceids.

Superfamily STROPHOMENACEA Schuchert, 1896

Concavo-convex or resupinate, pseudopunctate brachiopods usually with a persistent supraapical foramen which became sealed up by shell deposit in some later stocks so that mature individuals were either unattached or, exceptionally, cemented by part of the pedicle valve to a foreign body; cardinal process bilobed; pseudodeltidium sometimes completely closing the delthyrium, chilidium when present consisting of a simple convex arch. Ordovician to Carboniferous.

Family Strophomenidae King, 1846

Strophomenaceids with a pair of simple teeth usually supported by small dental lamellae; pseudodeltidium never completely closing the delthyrium, chilidium always present; brachia lacking skeletal support but apparently consisting of a pair of very low spires exceptionally impressed on the internal shell surface. Ordovician to Carboniferous.

Strophomeninae, n. subfamily

Strophomenids usually with a functional pedicle throughout ontogeny but sometimes lying free on the substratum due to the sealing up of the supra-apical foramen during maturity Ordovician to Carboniferous. Type genus, *Strophomena* de Blainville.

Leptaenoideinae, n. subfamily

Strophomenids attached throughout ontogeny by the cementation of the umbonal region of the pedicle valve to a foreign body. Middle Silurian to Lower Devonian. Type genus, *Leptaenoidea* Hedström.

Discussion.—The proposed family Rafinesquinidae Caster (1939) is synonymous with Strophomenidae King, 1846, as emended above. The only way to continue recognizing both families is to relegate all resupinate forms to the Strophomenidae, a patently artificial discrimination.

The adoption of secondary attachment by cementation in two strophomenid stocks (*Leptaenoidea* Hedström and *Leptaenisca* Beecher) seems to merit the division of the strophomenids into two new subfamilies. Cementation constituted a profound change of habit and was also achieved independently of this development by other strophomenoids.

Family Stropheodontidae Caster, 1939

Strophomenaceids lacking a functional pedicle with the simple teeth and dental lamellae replaced by denticles subsequently spreading along the hinge-line; socket ridges abbreviated subsequent to the loss of dental lamellae becoming obsolescent or disappearing completely, exceptionally forming buttresses to the cardinal process lobes; pseudodeltidium initially small, apical, becoming progressively larger and in some stocks ultimately closing the delthyrium completely; chilidium initially massive becoming degenerate and in some stocks ultimately completely lost. Upper Ordovician to Upper Devonian.

Subfamily Stropheodontinae Caster, 1939

Stropheodontids which lay free on the substratum during maturity. Upper Ordovician to Upper Devonian. Type genus, *Stropheodonta* Hall.

Liljevallinae, n. subfamily

Stropheodontids which were attached throughout ontogeny by cementation of the pedicle valve to a foreign body. Middle Silurian. Type genus, *Liljevallia* Hedström.

Discussion.—The stropheodontid affinities of *Liljevallia* are revealed in the development of denticles along the hinge-line on either side of the delthyrium, the absence of dental lamellae and simple teeth, and the brachyprionid muscle scar. The stock, then, like the leptaenoideinids and the orthotetaceids is illustrative of the development of cemented forms from a number of unattached independent strophomenoid ancestors. Hitherto *Liljevallia*, *Leptaenoidea*, and *Leptaenisca* have usually been placed within the Davidsoniinae but each genus has pronounced affinities with either the Strophomenidae or the Stropheodontidae and it seems better to erect new subfamilies in the manner proposed above than to continue previous practice.

Christianiidae, n. family

Concavo-convex strophomenaceids with a lophophore platform consisting of a pair of discrete, U-shaped loops presumably giving support to a schizolophous lophophore; pseudodeltidium and convex chilidium well developed, cardinal process bilobed, socket ridges strong; supra-apical foramen persistent throughout ontogeny. Middle and Upper Ordovician Type genus, *Christiania* Hall and Clarke.

Discussion.—*Christiania* represents an isolated terminal development out of one of the early strophomenoid divergences which is not closely related to any other known stock. The presence of a lophophore platform suggests affinities with the Plectambonacea, but it is more probable that the platform, which is not like any plectambonaceid structure, represents an independent convergent development for in other respects and especially in the possession of a bilobed cardinal process *Christiania* is strophomenaceid.

ORTHOTETACEA, n. superfamily

Strophomenoids without a functional pedicle; pedicle valve usually greatly modified and cemented by the umbo or a greater part of the shell surface to a foreign body; brachial valve convex throughout ontogeny; cardinal process bilobed often greatly extended into the pedicle valve, sometimes highly modified; lophophore probably spirolophous in all stocks, exceptionally impressed and supported by spirally coiled calcareous ribbons. Upper Ordovician to Triassic.

Family Orthotetidae MacEwan, 1939

Orthotetaceids with a variable but well developed hinge-line and interarea in the pedicle valve; pedicle valve consisting of one continuous chamber; pseudodeltidium of earlier stocks apical and chilidium correspondingly massive, in later stocks pseudodeltidium completely covering delthyrium, chilidium vestigial, perideltidium always present; shell surface usually finely costellate with additional radial plicae in many later stocks. Upper Ordovician to Permian.

Subfamily Orthotetinae Waagen, 1884

Orthotetids equipped with a pair of dental lamellae often extravagantly developed and in various stages of convergence and coalescence. Upper Ordovician to Permian. Type genus, *Orthotetes* Fischer.

Schuchertellinae, n. subfamily

Orthotetids which have lost the dental lamellae through obsolescence. Devonian to Permian. Type genus, *Schuchertella* Girty.

Subfamily Davidsoniinae King, 1850

Orthotetids lacking costellate ornamentation; pseudodeltidium and chilidium well developed; dental lamellae obsolescent, sockets deep bounded by flaring socket ridges fused with cardinal process; both valves bear the impressions of a pair of spirally coiled brachia forming very ow cones with the apices directed towards the brachial valve. Middle Devonian. Type genus, *Davidsonia* Bouchard.

Discussion.—The term perideltidium (Dunbar and Condra 1932, p. 67): has been given to a pair of triangular surfaces forming part of the interarea of the orthotetid pedicle valve and lying lateral to the pseudodeltidium although not necessarily adjacent to it. The perideltidium is variable in area and development but is an integral part of the interarea and is not an occurrence dependent on shell exfoliation.

Each area is slightly elevated above the rest of the interarea and in addition to being ornamented by growth lines parallel to the hinge-line is also feebly striated at right angles to the hinge-line so that the resultant series of grooves and ridges does not radiate from the umbo and lie obliquely to the perideltidial boundaries. Serial sections of a number of orthotetids substantiate the conclusions of Dunbar and Condra that the perideltidial boundaries are represented by a sharp deflection of both lamellar and fibrous layers. It can also be observed that the striations represent crenulations of the lamellar layer and that part of the fibrous layer adjacent to it. One would have anticipated constrictions on the hinge-line of the brachial valve corresponding to the deflected edges of the perideltidium, but none can be observed, and no plausible reason can be suggested for this differentiation of the interarea.

Apart from including the Davidsoniinae within the Orthotetidae the division of the family into two subfamilies dependent upon the presence or absence of dental lamellae is, in the opinion of the writer, more than a convenient morphological grouping for it seems to have been one of the natural consequences of orthotetid development.

The earliest known orthotetid, *Fardenia* Lamont, a biconvex form equipped with dental lamellae, appeared towards the end of the Ordovician and flourished throughout the Silurian. There is evidence to suggest (Williams, 1950, p. 120) that by the end of Silurian times sufficient divergence had occurred within the stock to give rise to a schuchertellid, which had lost the dental lamellae by obsolescence, and also a concavo-convex Schellwienella (like the Lower Devonian *S. umbraculum* (Schloth.)) with strongly developed divergent dental lamellae.

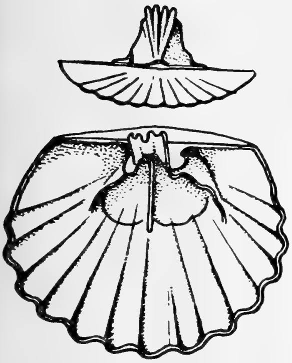
It is probable that two such forms were ancestral to two main stocks, viz, orthotetinid and schuchertellinid which remained independent during their subsequent histories. The range of all described genera is consistent with this belief and there is no evidence to suggest that either stock was replenished from the other by obsolescence of the dental lamellae or the development of secondary ones.

With regard to the various genera equipped with well-developed dental lamellae it is noteworthy that the disposition of the lamellae seems to be closely related to the configuration of the pedicle valve. Thus Schellwienellas possess concave pedicle valves and divergent dental lamellae while all other orthotetinids have convex pedicle valves and dental lamellae which are parallel, convergent, or in various stages of coalescence. Taking into consideration the fact that the dental lamellae always occupied a constant position relative to the interarea, where they lay immediately beneath the teeth, it is reasonable to assume that their disposition was a function of the form and growth of the anterior wall of the pedicle valve. Consequently many species ascribed to such genera as *Sicelia*, *Orthotetina*, *Geyerella*, and *Meekella* may represent independent convergences rather than closely related stocks.

Gemmellaroiidae, n. family

Attached orthotetaceids with a long conical pedicle valve capped by a reduced operculiform brachial valve; hinge-line obsolescent, interarea completely lost except for a narrow elevated ridge in the pedicle valve representing the pseudodeltidium; articulation aided by the development in both valves of an excessively thickened margin serrated by oblique furrows; cardinalia massive, elongated, with the bilobed cardinal process and laterally extended socket ridges completely fused, in the interior of the pedicle valve the cardinalia is contained within a subcircular myophore chamber, about a third the length of the valve extending from the umbo almost to the periphery of the valve and lying immediately anterior to the pseudodeltidium; fibrous layer of shell adjacent to lamellar layer disposed in long sharp folds radiating from the umbo. Permian. Type genus *Gemmellaroia* Crossman.

FIGS. 8–12.—8, Orthotetinid morphology, *Meekella* White and St. John; interior of brachial valve (8a) with posterior view above; interior of pedicle valve (8b). 9, Scacchinellid morphology as typified by *Scacchinella* Gemmellaro; interior of brachial valve (9a); reconstruction of part of the pedicle valve interior (9b) showing the median septum and the transverse partitions. 10, Gemmellaroiid morphology as typified by *Gemmellaroia* Crossman; complete shell with a transverse section of the pedicle valve to show the shell structure and the disposition of the myophore chamber (10b), anterior view of brachial valve interior (10a). 11, Thecospirid morphology as typified by *Thecospira* Zugmayer; interior of brachial valve (11a), interior of pedicle valve (11b) tilted to show the muscle scar arrangement. 12, Diagrammatic representation of the interarea of the orthotetid pedicle valve to show the nature of the perideltidium (PE); lamellar layer (L), fibrous layer (F), pseudodeltidium (P), tooth (T).



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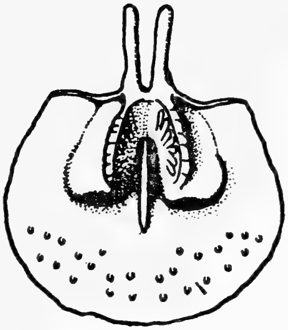

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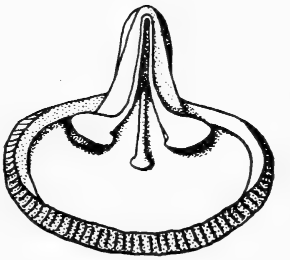

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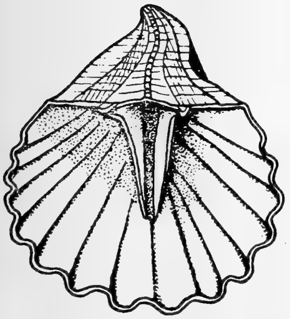

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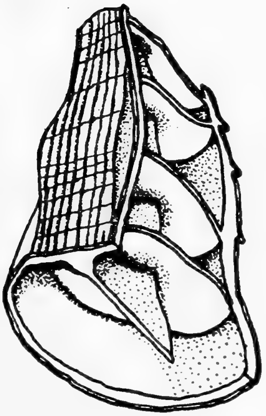

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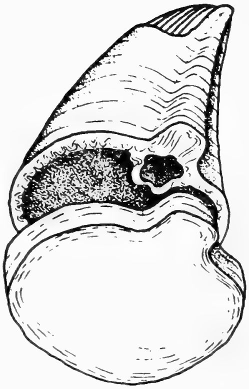

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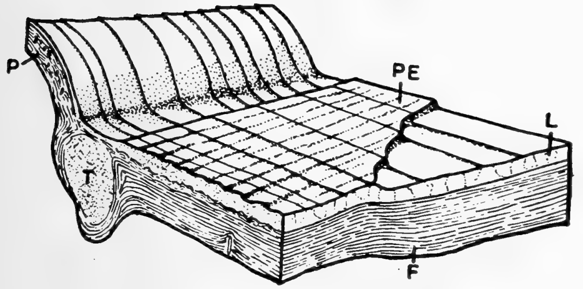

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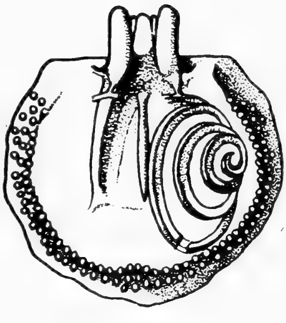

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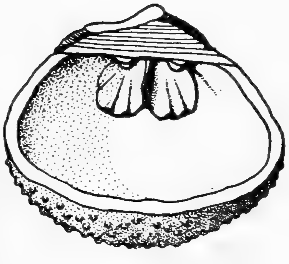

11b

FIGS. 8–12 (See opposite page for legend).

Discussion.—The gemmellaroiids represent a later divergence from a more generalized orthotetid stock in which a number of morphological modifications present in the orthotetids generally are carried to conclusion. Thus the excessive elongation of the pedicle valve and the reduction of the hinge-line is seen in late orthotetids like *Orthotetina* but never on the scale of the gemmellaroiids. The myophore chamber is especially characteristic of the family but is not unique for a similar structure evolved in an otherwise typical Permian orthotetid (*Orthotetella* King).

Scacchinellidae, n. family

Attached orthotetaceids, pedicle valve long, conical twisted with longitudinally striated interarea, brachial valve gently convex, exterior spinose without radial ornamentation; interior of pedicle valve with a strong median septum extending anteriorly for over half the length of the shell and divided into a series of chambers by the deposition of a variable number of transverse partitions the last formed chamber presumably being the only one occupied by the viscera; brachial valve with a long bilobed cardinal process which extended well into the pedicle valve on either side of the median septum; socket ridges small, adductor muscle scars impressed on the inner surfaces of a pair of long, thick ridges extending anteriorly from the cardinal process bases. Permian. Type genus, *Scacchinella* Gemmellaro.

Discussion.—The scacchinellids are unique among the orthotetaceids and indeed among all brachiopods in the division of the pedicle valve into a series of chambers by the deposition of transverse partitions. The writer has observed in an occasional *Derbyia* the apparently natural occurrence of thin flaps of fibrous shell deposit projecting into the body chamber and a similar occurrence is reported by Licharew (1928, p. 272) in the gemmellaroiid *Tectarea*. But in the scacchinellids the partitions were apparently a regular feature of all mature individuals and were presumably a consequence of the great disparity between the volume of the soft parts and the excessive elongation of the pedicle valve.

Family Thecospiridae Bittner, 1893

Orthotetaceids attached to a foreign body by cementation of the pedicle valve, exterior tuberculate without radial ornamentation but sometimes rugate; interarea of pedicle valve entire, without any definition of the pseudodeltidium, interarea of brachial valve vestigial,

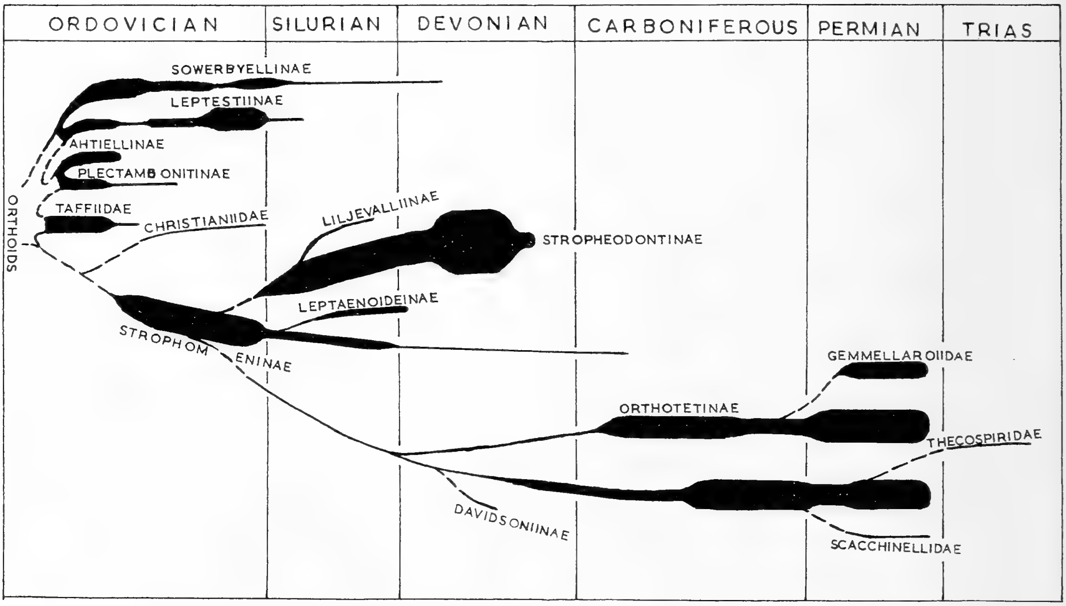

Fig. 13.—The stratigraphical distribution of the strophomenoid brachiopods, including the thecideids; the size of the suprageneric categories figured in the chart is proportionate to the number of genera included in each category as well as their stratigraphical range.

childium absent; pedicle valve with strong unsupported teeth and a small broad muscle scar divided medianly by a low median septum; brachial valve with an erect cardinal process, functionally bilobed but united medianly to form a tripartite structure, sockets deep, muscle scars contained within a pair of subparallel ridges extending anteriorly from the cardinalia and divided medianly by a low median ridge; cardinal process bases prolonged into a pair of short processes which support a pair of spirally coiled calcareous ribbons directed towards the lateral slopes of the pedicle valve; brachial ribbon sharply folded throughout its length to give a V-shaped cross section. Triassic. Type genus, *Thecospira* Zugmayer.

Discussion.—The orthotetaceid features of *Thecospira* are so striking and numerous that it cannot be excluded from the strophomenoids because its lophophore was supported by a pair of spirally coiled calcareous ribbons. The shell is strongly pseudopunctate, the spicules penetrate the internal surfaces which are tuberculate and though they do not penetrate the lamellar layer they are excessively prolonged to give the exterior a bluntly spinose appearance. Other strophomenoid features include the mode of attachment, the entire interarea of the pedicle valve (compare the stropheodontids and a similar tendency in those orthotetaceids with a vestigial chilidium) the cardinal process and the muscle scars which are reminiscent of late orthotetaceids like *Derbyia*.

The presence of calcified spiral supports in *Thecospira* then does not signify that the stock was related to the rostrospiroids or spiriferoids; they represent an independent development out of a spirolophous orthetetaceid.

BIBLIOGRAPHY

Beecher, C. E. *Studies in evolution.* 1901.

Caster, K. E. *A Devonian fauna from Colombia.* Bull. Amer. Pal. **24** (83). 1939.

Dunbar, C. O., and Condra, G. E. *Brachiopoda of the Pennsylvanian System in Nebraska:* Nebraska Geol. Surv. Bull. **5:** ser. 2. 1932.

Licharew, B. *Über einige seltene und neue Brachiopoda aus dem Unterperm des nördlichen Kaukasus.* Palaeont. Zeitschr. **10:** 258–289. 1928.

Kozlowski, R. *Les brachiopodes Gothlandiens de la Podolie Polonaise.* Palaeont. Polonica **1**. 1929.

Opik, A. *Über die Plectellinen.* Act. et Comm. Univ. Tartu: 1–85. 1932.

———. *Über Plectamboniten.* Act. et Comm. Univ. Tartu: 1–79. 1933.

Percival, E. *A contribution to the life history of the brachiopod* Terebratella inconspicua *Sowerby.* Trans. Roy. Soc. New Zealand **71** (1): 1–23. 1944.

Schuchert, C., and Le Vene, C. M. *Brachiopoda.* Fossilium catalogus, pars 42.

Thomas, I. *The British Carboniferous Orthotetinae.* Mem. Geol. Surv. Great Britain. Palaeont. **1** (2): 33–134. 1910.

Ulrich, E. O., and Cooper, G. A. *Ozarkian and Canadian Brachiopoda:* Geol. Soc. Amer., Spec. Paper 13. 1938.

Williams, A. *Llandovery brachiopods from Wales with special reference to the Llandovery district.* Quart. Jour. Geol. Sci. **108:** 85–136. 1951.

PALEOBOTANY.—Prosseria grandis, *a new genus and new species from the Upper Devonian of New York.*[1] Charles B. Read, U. S. Geological Survey. (Communicated by Roland W. Brown.)

The extensive collections of fossil plants made by C. S. Prosser from Devonian horizons in New York and Ohio contain numerous specimens of interest to students of Paleozoic floras. One of the most remarkable of these specimens is a large slab of black shale and its counterpart carrying as an incrustation the remains of an unusual representative of the Articulatae. The literature on Devonian floras contains no reference to any genus that may be extended to include this plant. In consequence this fossil is referred to a new genus, *Prosseria,* named in honor of the collector. There follows a discussion of the type specimen and its possible relationships.

Pteridophyta
Articulatae
?Pseudoborniales

Prosseria, n. gen.

Generic characters at present defined by the single known species.

Prosseria grandis, n. sp.

Diagnosis.—Plant large, stem 25 mm in di-

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[1] Publication authorized by the Director, U. S. Geological Survey.

ameter in the type, articulate, surface smooth. Nodes enlarged (40–50 mm in diameter) and giving off both branches and whorls of leaves. Leaves about 18 (?), 9–11 visible on one side, apparently in fascicles of three, emerging from definite points of insertion at the node; linear and long (33 cm long and 6 mm wide), narrow at base and enlarging gradually upward for about 15 centimeters, nervation indistinct. Branches, 2 at each node, emerging from opposite sides of the stem, only the bases preserved in the type specimen.

Collected by C. S. Prosser in 1889 from the "Upper Genesee" shale (West River shale, Genesee group), Kimble Gully, 1 mile southeast of Penn Yan, Yates County, N. Y.

Discussion.—The general aspect of *Prosseria grandis* is shown in Fig. 1. The nearly smooth stem with enlarged nodes, the whorl of linear leaves, and the opposite branching are striking features of the fossil. The leaves, as has already been pointed out, are in fascicles of three on the one side exposed. Details of the lower portions of the leaves and of the bases are rather vague, however, and do not permit critical study. Judged from the occurrences of leaves attached only at the upper one of the two nodes and their absence in the lower node, the appendages must have developed definite abscission layers. It will be seen that there are three distinct leaf bases in the half of the flattened stem exposed at the upper node. These are circular, and leave a distinct impression, suggesting definite articulations by their clear-cut aspect as indicated above.

The two lateral organs at each node are obviously in a different category from the strap-shaped leaves. Their larger size, the open angle they make with the stem, and their frayed ends (indicative of the absence of an abscission layer) are proof of this. These are regarded by the writer as lateral branches.

With the meager data at hand concerning this fossil it is obviously unwise to attempt any estimate of the size of the entire plant. The plant may have been quite large, in which case the specimen is but a branch. On the other hand the plant very likely was a relatively small one, and the axis here preserved is the main shoot.

The affinities of *Prosseria grandis* are beyond question with the Articulatae. The plant may possibly be related to *Pseudobornia* Nathorst. The features observable in the material are, however, scarcely sufficient to be conclusive. It will be recalled that *Pseudobornia*[2] is characterized by large articulated stems with one to two branches at each node. The leaves are in whorls of four, are short-stalked, dichotomously divided, and with toothed margins. Their general aspect is somewhat plumose. The fructification is a strobilus said to be comparable with *Cheirostrobus* Scott.[3] The single well-known species, *Pseudobornia ursina* Nathorst, is from the Upper Devonian of Bear Island. This genus is an isolated type which, in the opinion of many paleobotanists, shows affinities with the *Sphenophyllales*. The linear leaves of *Prosseria* contrast strongly with the plumose ones of *Pseudobornia* and provide adequate grounds for generic separation. The stem provides little information of value in determining relationships, and, in the absence of fertile structures of *Prosseria*, it is obviously impossible to reach any definite conclusion regarding exact affinities.

There are likewise known the Middle Devonian *Calamophyton* and *Hyenia*, grouped by Krausel and Weyland in the Protoarticulatae. These plants, at least in their general makeup, are far more primitive types than *Prosseria*, showing only a semiverticillate arrangement of much smaller and definitely dichotomous leaves.

To the writer it would seem that *Prosseria* is much more closely related to the *Sphenophyllales* or *Pseudoborniales* than to the *Equisteales*. The greatly enlarged nodes of *Prosseria* certainly indicate this. Such a condition is quite characteristic of the stems of *Sphenophyllum*, common in the Carboniferous. Nathorst's figures of *Pseudobornia ursina* show the same condition. Stems of *Calamites* do not, however, show this.

Comparison with the stems identified by Dawson as *Calamites inornatus*[4] and later referred by White to *Pseudobornia*[5] is unsatisfactory. Dawson's plant is a broadly ribbed type with the nodes scarcely enlarged. The prominent nodal scars so characteristic of *Prosseria* are not shown

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[2] NATHORST, A. G., *Zur fossilen Flora der Polarländer*. Kongl. Svenska Vet.-Akad. Handl. **36** (2): 25–28, pl. 7, figs. 9–13, pl. 8, figs. 1, 3–13, pl. 9, pl. 10, figs. 1–3. 1902.

[3] SCOTT, D. H., *On* Cheirostrobus, *a new type of fossil cone from the calciferous sandstone*. Philos. Trans. Roy. Soc. London **189**: ser. B, 1–34, pls. 1–6. 1897.

[4] DAWSON, J. W., *Flora of the Devonian period in northeastern America*. Quart. Journ. Geol. Soc. **18**: 310, pl. 17, fig. 56. 1862.

[5] WHITE, D. in Kindle, E. M., *Stratigraphic relations of Devonian shales of northern Ohio*. Amer. Journ. Sci. **34** (4): 210. 1912.

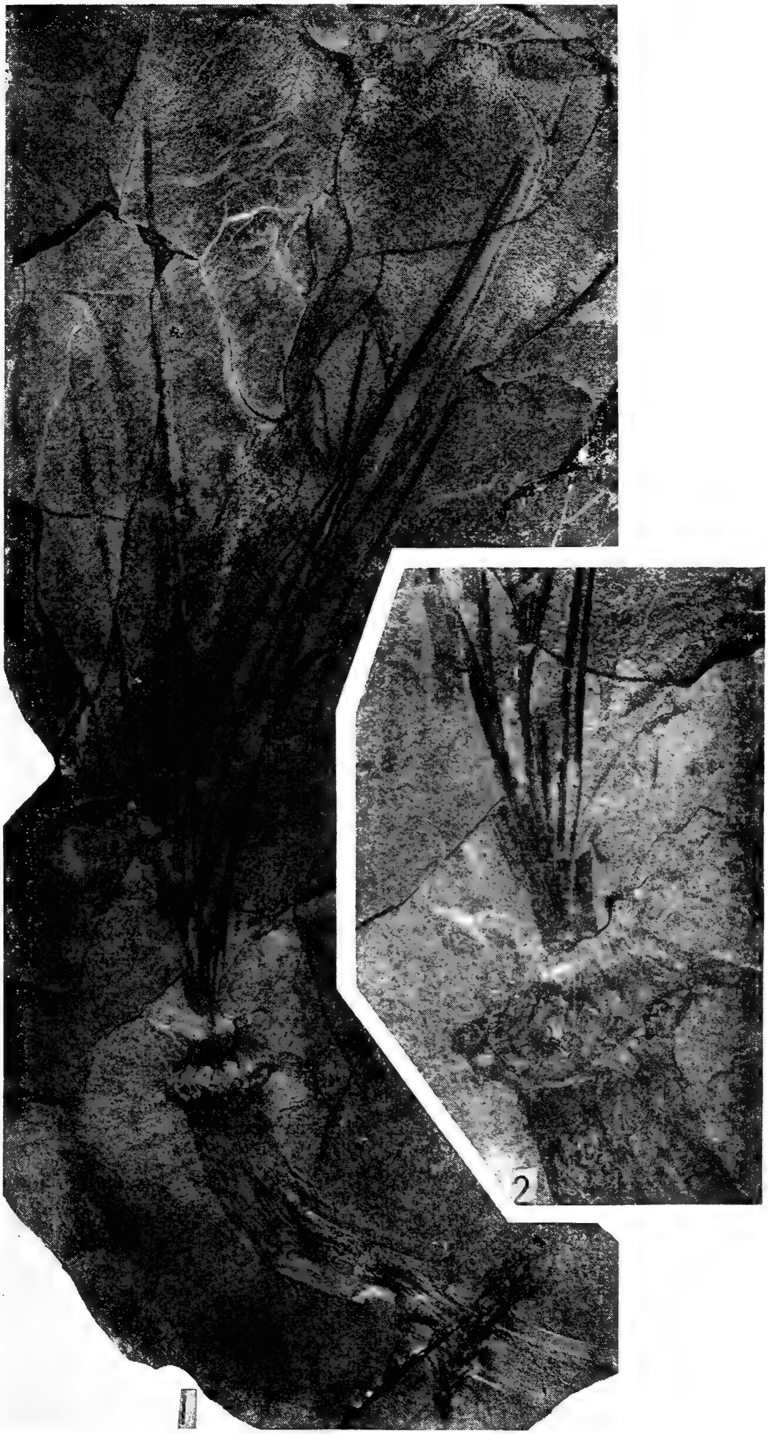


Fig. 1.—Photograph of the shale slab carrying the specimen of *Prosseria grandis*, showing the great length of the leaves, the enlarged nodes, and the smooth stem, × ½.

Fig. 2.—Photograph of the upper of the two nodes of the preceding figure showing the leaf bases and the opposite branch(?) bases, × 1.

in the figure of the type specimen of *C. inornatus*. It is, in fact, extremely doubtful if there is sufficient information available to permit the proper generic determination of the latter. It is quite likely a *Protocalamites*.

This new plant, although only its vegetative features are known and those imperfectly, has a rather important morphological significance. Briefly, *Prossera grandis* is an early member of the Articulatae of early Late Devonian age (Portage). It shows definite whorls of large and long-divided leaves. The nodal structure suggests affinity with the *Sphenophyllales*. The leaves are, however, far larger than those of the Carboniferous Articulatae. These large leaves in this very early type hardly support the frequent claims that the leaves of this group were originally microphyllous. Rather, the suggestion, based on arrangement of the known members of the Articulatae in chronologic order with *Prosseria* taking its place near, at least, to the base, is that the series may be one of reduction from megaphylls rather than expansion from microphylls.

MYCOLOGY.—*A new species of* Protodontia *from British Columbia*. G. W. Martin, State University of Iowa.

In January 1950 Dr. Ruth Macrae, of the Division of Botany and Plant Pathology, Department of Agriculture, Ottawa, Canada, sent me two specimens of a tremellaceous fungus, accompanied by careful notes and drawings, which obviously represented the same species but which were clearly distinct from any I had previously seen or to which I could find reference in the literature. Both had been collected the preceding year by W. G. Ziller on slash of black cottonwood in central British Columbia. The specimens, although sporulating freely, appeared to be incompletely developed and the assignment to a genus offered great difficulty, hence I laid them aside awaiting fuller information. Meanwhile, two additional collections from the same area were found in the collections at Ottawa, one collected by Mr. Ziller and one by Dr. M. K. Nobles. Dr. Macrae kindly sent me the balance of the material from Ottawa and Mr. Ziller let me see the even more abundant material of all four collections deposited in the Forest Pathology Collection of the Dominion Department of Agriculture at Victoria, British Columbia. On the basis of this material, I feel justified in describing the species.

Protodontia oligacantha, sp. nov.

Fructificationibus late effusis, resupinatis, tenuibus, mediis fuligineis vel avellaneis, ad fimbrias albas pallescentibus; aculeis sparsis, fimbriatis, albis, ad 0.6 mm longis; hymenio in basidiis et dendrophysibus dense aggregatis consistente; subhymenio hyalino; hyphis fundamenti fulvis; probasidiis globosis vel pyriformibus, plerumque 13–20 × 9–12μ, denique cruciatim-septatis; epibasidiis crassis breviculis latis, 2–2.5(–3)μ; basidiosporis cylindraceo-curvulis, apiculatis, (9–)10–12(–13) × (4–)4.5–5(–5.5)μ, per repetitionem germinantibus.

Broadly effused, up to 13 × 5 cm in extent, possibly larger, Benzo Brown to Cinnamon Drab, fading to buff or pallid near the broad, thin, fimbriate, white margin; waxy when moist, the hymenial surface drying horny; spines blunt, broad, somewhat fimbriate, white, up to 600μ long and 350μ in diameter at base, tapering toward tips, sparsely and irregularly distributed; in section 65–230μ thick between the spines, composed of a colorless hymenial layer 20–40μ thick, a yellowish basal layer of horizontal hyphae and an intermediate layer of variable thickness, clear yellow by transmitted light, which penetrates the spines, composed of indistinct agglutinated hyphae intermingled with crystalline accretions; hymenium continuous, covering both

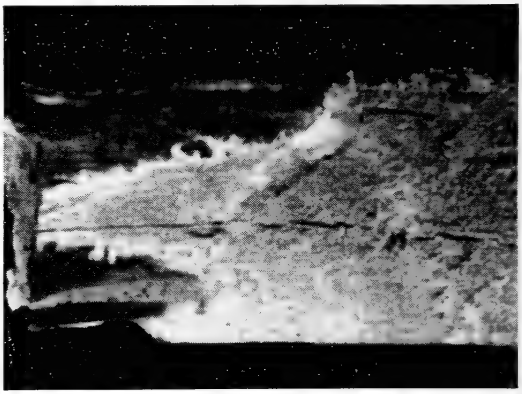


FIG. 1.—*Protodontia oligacantha*, type: Habit, × 1, showing fimbriate margin.

FIG. 2.—*Protodontia oligacantha*, type: Longitudinal section of spine, showing hymenium and sterile tip, × 80.

spines and area between them, except at tips of spines, composed of colorless basidia and dendrophyses; dendrophyses 3–4μ in diameter at base, branching subdichotomously several times and irregularly attenuated toward the tips, sometimes with clamp-connections; probasidia globose to ovate or pyriform, mostly 13–20 × 9–12μ, becoming cruciate-septate, each cell producing a thick, rather short epibasidium, 2–2.5(–3)μ in diameter; basidiospores cylindrical to allantoid, usually with numerous small guttules, sometimes with 1–3 large guttules and numerous smaller ones, (9–)10–12(–13) × (4–)4.5–5(–5.5)μ, germinating by repetition.

British Columbia: Cottonwood, August 3, 1949, W. G. Ziller, V-*5013* (DAOM *21881*), TYPE. Other collections examined: Cottonwood, July 26, 1949, M. K. Nobles, V-*5247* (DAOM *22974*); Cinema, August 11, 1949, W. G. Ziller, V-*5084* (DAOM *22973*) and V-*5087* (DAOM *21934*). All on dead wood of *Populus trichocarpa* T. & G. Numbers cited are those of Herb. Lab. For. Path. Victoria (V) and Myc. Herb. Sci. Serv. Dept. Agr. Ottawa (DAOM). Portions of all except V-*5084* are in Myc. Coll. S. U. I.

The specific epithet is based on ὀλίγος, few, and ἄκανθα, spine.

The outstanding characteristics of *P. oligacantha* are the sparse development of the spines and the broad, spineless, fimbriate margin (Fig. 1). Where most abundant, the spines number 3–5 to a square millimeter. They are fertile over most of the surface, as is the hymenium between them, but the extreme tip is often sterile (Fig. 2), owing to protrusion of an extension of the intermediate yellow layer, giving them a fimbriate appearance when examined dry under a binocular. They tend to be borne in lines on whitish strands, which makes the hymenial surface appear faintly reticulate under a lens. Some specimens of *Eichleriella spinulosa* (B. & C.) Burt bear tubercles on the hymenial surface which may approach in abundance the spines of *P. oligacantha*, but the much thicker, darker fructification, the larger spores and basidia and the strongly determinate margin of the former species mark it as clearly distinct. The basidia and spores are of approximately the same size as those of *E. macrospora* (Peck) Martin, which may bear scattered tubercles and is sometimes subfimbriate and indeterminate when young, but the thick, determinate fructification of mature collections of that species and the characteristic texture, difficult to describe, but readily recognizable when known, make it impossible to consider it the same as the Canadian fungus. In the four ample collections which have been studied, there is no suggestion that *P. oligacantha* ever develops a determinate margin. It seems probable, however, that collections made later in the season might show a somewhat more extensive development of the spines. The basidia and spores (Fig. 3) are characteristic of the Tremellaceae. There is often a suggestion of a clamp connection at the base of the basidium, but in most cases this cannot be seen. The dendrophyses (Fig. 3, *c*) are rather difficult to see since the terminal portion does not stain.

The largest fructifications examined were 13 × 4 cm and 12 × 5 cm respectively, one of

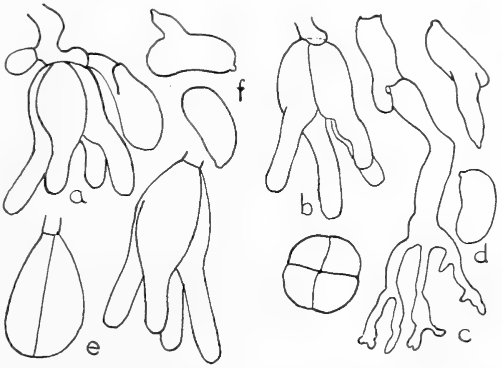


FIG. 3.—*Protodontia oligacantha*: *a–d*, no. *V-5087*. *a*, Two basidia and ovate structure, probably a very young basidium (note beak on basidium at right); *b*, two basidia, one in apical view; *c*, dendrophysis; *d*, two spores, one preparing to germinate by repetition. *e–f*, No. *V-5013*. *e*, two basidia, *f*, two spores, one preparing to germinate by repetition. All × 1,000.

these measurements secured by matching two broken pieces. The growth may well become much more extensive.

Some years ago (Mycologia **24:** 508–511. 1932) I discussed the genus *Protodontia* with particular reference to our commonest species, which I referred to *P. uda* v. Höhn., and at that time commented on the genus *Protohydnum* Möll., in which *Protodontia* is often included. Recently (Univ. Iowa Stud. Nat. Hist. **19** (3): 63. 1952), I reported *P. piceicola* (Kühner) Martin from Ontario. A collection from Louisiana by Langlois, determined by him as *Protohydnum lividum,* in the herbaria of the U. S. Dept. of Agriculture and the Missouri Botanical Garden, may well be that species and a *Protodontia,* but the generic transfer should be made only by one who has access to adequate European material. These seem to be the only species known from the United States and Canada.

Dr. M. A. Donk has been kind enough to let me see some of his notes on *Protodontia.* He believes that what I have referred to *P. uda* is in reality distinct from the European form. This may be correct. I have not seen enough European material to be certain it is not and have depended mainly on published descriptions for the determination of our collections. These, however, show substantial variation but nothing beyond what may, in my opinion, be considered as due to differences in degree of maturity or as responses to local environmental fluctuations. Whelden (Mycologia **29:** 100–115. 1937), who studied cytologically an American collection referred to *P. uda,* reports that his material had been compared with von Höhnel's type by Dr. D. P. Rogers, who found them to agree exactly.

ICHTHYOLOGY.—*Ten new American gobioid fishes in the United States National Museum, including additions to a revision of* Gobionellus.

ISAAC GINSBURG, U. S. Fish and Wildlife Service. (Communicated by L. P. Schultz.)

During revisional studies of the genera of American fishes, the following 10 undescribed species and subspecies discovered in the U. S. Fish and Wildlife Service and the U. S. National Museum are here named and briefly described. All holotypes are deposited in the National Museum.

Figures of proportional measurements given below refer to percentages of the standard length. Lengths of the pectoral and ventral fins denote the length of their longest rays, from their point of articulation, as determined at the surface without dissection, to their distal margin. The given lengths of specimens refer to the total length, including the caudal fin, unless otherwise stated.

The numbers of fin supports are of paramount importance in the classification of fishes, including gobies. The precise structure of the fins of fishes in general, namely, the different kinds of fin supports comprising the fins, differs largely by family or other major taxonomic groupings. The variability and relative numbers of the different supports differ by species or population of lower rank, and also by higher taxonomic groups. The numbers of fin supports have been widely used in taxonomy; but the broader problem of the comparative morphology of the fins of fishes in general has been largely neglected. Lately, this subject began to engage the attention of investigators. Hubbs (Copeia, 1943: 134; 1945: 75) raises the question of the use of a certain fin formula in describing gobioid fishes, in connection with a discussion of the structure of the fins of other fishes. Beebe (Zoologica **27:** 45. 1942) is of the opinion that the last two approximated dorsal rays of *Dixonina*—a genus belonging to a different order than gobies—and related genera should be enumerated separately instead of counting them together as one ray. However, a thorough study of the comparative morphology of the fins in the major groups of fishes still remains to be made. As the fin structure differs largely by major groups, the proper and most advantageous method of enumeration, and any formula expressing such enumeration, will differ by such major groups.

In the superfamily Gobioidea the structure of the fins is as follows: The first dorsal consists of flexible (with few exceptions), unsegmented fin supports which are evidently homologous with the pungent spines of other fishes having two dorsal fins. The first fin support of the second dorsal is, as the fin supports of the first dorsal, likewise flexible and unsegmented, and is presumably also homologous with the pungent spine in the same position of other fishes (although no thorough study has as yet been made to verify this assumption). The first unsegmented fin support of the second dorsal is followed by a variable number of segmented, and variously branched rays, the last two of which are very closely approximated at the base. The structure of the anal is the same as that of the second dorsal.

The above described structures apply to all the species in the superfamily and virtually to all the individuals of any species. Exceptions from the general rule that are now and then found in individual fish—and such exceptions comprise less than 1 percent of the combined counts of all the species examined—are to be considered as slight abnormalities rather than as representations of a normal individual variability. As these are superfamily characters, there seems no point in repeating these facts under each species, either in words or by a formula, as it is unnecessary to repeat any other superfamily character in the species descriptions. Consequently, in the descriptions here given the following uniform method is adopted in enumerating those rays that are of importance in separating the species: All counts are given in Arabic numerals. A semicolon separates the counts of the two dorsals and a hyphen connects the extremes of the range of the count of any given fin. The first unsegmented fin support of the second dorsal, and anal, is included in the count, while the last two approximated rays of both fins are counted as one. This is the method I used uniformly in previous publications on gobioids. If it is desired to get the number of segmented rays only, that is, to exclude the first fin support and count the last two as one ray, 1 is to be subtracted from the figures given below; to include the first and count the last two separately, 1 needs to be added; excluding the first and counting the last two separately, the numbers will be the same as those given below.

The rays in the pectoral fin of gobies generally do not differ in essential structure, except that some of the marginal rays grow progressively shorter, and the extent of branching decreases outwardly. In the following descriptions all the pectoral rays are included without distinction in the same count.

Family Eleotridae

Dormitator cubanus, n. sp.

D 7; 8–9. A 8–9. P 15. Sc 33–35. No mucous pores on preopercular sulcus. Total number of gill rakers in outer row of first gill arch, in a 94-mm specimen, 29. Head 30–31, postorbital part of head 15.5–16.5, caudal 27–28, ventral 23.5–24.5, pectoral 23–25.5. Body with a median longitudinal row of very diffuse spots; a dark shoulder spot above pectoral base; a dark, narrow, short, oblique band on cheek, under anterior margin of pupil to end of maxillary; the two dorsals and caudal with rows of small dark spots, roughly transverse on caudal and oblique on dorsals. (No oblique transverse light bands on body against a darker background as in related species, but their absence possibly due to fading.)

Holotype.—U.S.N.M. no. 55668. San Cristóbal, Cuba; C. H. Eigenmann; 1902; female 82 mm.

Paratypes.—U.S.N.M. no. 123234, a male obtained with the holotype, 73.6 mm in standard length with the caudal broken, approximately 94 mm in total length. U.S.N.M. no. 55688; Pinar del Río, Cuba; C. H. Eigenmann; March 1902; female 48 mm.

Remarks.—This is a well-marked species and differs sharply from its congeners in the number of gill rakers. Specimens of comparable size, with that stated above, of the other species have a total of 51 or more gill rakers in the outer row of the first gill arch. It also differs in lacking pores on the preopercular sulcus, and in averaging fewer dorsal and anal rays and shorter fins; although there is more or less intergradation in these latter characters. Taking its character pattern as a whole, *cubanus* is sharply defined and rather easily distinguishable. It is probably a highly localized species and confined to some fresh-water streams in Cuba, as 445 specimens of *Dormitator* examined from the western Atlantic coasts, ranging from Texas to Brazil, and from several West Indian Islands including Cuba, all belong to the common Atlantic species, *maculatus*.

The three specimens forming the basis of this account were collected by Eigenmann (Bull. U. S. Bur. Fish. **22** (1902): 211–236. 1903) during his investigation of the cave inhabiting fishes of Cuba, in 1902, when he made many striking discoveries. He then obtained both *maculatus* and *cubanus* and recorded them together under the former designation.

Dormitator latifrons mexicanus, n. subsp.

D(6) 7 (8); (8) 9–10. A (9) 10–11. P 14–16. Sc 34–36.—Preopercular sulcus with pores, usually 4 in number. Total number of gill rakers in outer row of first gill arch, in 3 specimens 242–256 mm (from Colima, Mexico), 132–145, and in the same specimens, head 30.5–32.5, postorbital 16–18, caudal 30.5–32.5, ventral 20–22, pectoral 22.5–24. In the holotype, gill rakers 107, head 33, postorbital 19, caudal 34.5, ventral 21.5, pectoral 25.5. Body dark with rather narrow, obliquely transverse, diffuse, lighter cross bands; a large very dark shoulder spot near and over pectoral base; a narrow dark band on cheek under anterior margin of pupil to end of maxillary; posterior part of head with dark longitudinal, nearly parallel bands, rather faint to well defined; a somewhat curved band at pectoral base.

Holotype.—U.S.N.M. no. 7350. San Lucas, Lower California; I. Xanthus; male 140 mm.

Remarks.—Other 49 specimens 24–256 mm examined from the Pacific coast of Mexico ranging from La Paz in the Gulf of California to Salina Cruz in the gulf of Tehuantepec.

The subspecies *mexicanus* differs from *latifrons* chiefly in the number of gill rakers and the head length. Both of these characters differ also intraspecifically with the size of the fish and it is necessary to compare specimens of like size. Two specimens of *latifrons* from the Pacific coast of Panamá, 235–259 mm, comparable in size with the large specimens described above, have gill rakers 149–164 and head length 33.5–38. *D. mexicanus* also averages a shorter caudal, ventral, pectoral and postorbital part of the head; but it intergrades considerably with *latifrons* in these characters. The two are apparently allopatric populations on the Pacific coast of Mexico and Central America, respectively. In this preliminary account the few largest specimens are compared and they do not show intergradation in the two chief characters. However, a comparison of the 50 specimens examined of *mexicanus* with 47 specimens of *latifrons*, segregated by comparable size groups shows that they intergrade with a degree of divergence of subspecies magnitude.

The name *latifrons* was proposed by Richardson for two specimens from the "Pacific Ocean." It has since been used for the common eastern Pacific species of *Dormitator*, including Mexico and Central America, or the name was placed in the synonymy of *D. maculatus*, depending on whether an author treated the eastern Pacific population as a distinct species, or he treated that population as being conspecific with that from the western Atlantic. As the common eastern Pacific species is here divided into two subspecies, the name *latifrons* is hereby restricted to the Panama population, since it is more likely that Richardson's specimens came from the coast of central America than that of Mexico.

Guavina micropus, n. sp.

D 7; 10. A 10. P 16. Sc 89. Almost completely scaled, except underside of head, and preopercular sulcus, and a small area on side of snout in front of eye, altogether or largely scaleless. Scales on posterior part of body rather weakly spinulose, others cycloid. Ventral 11.5, pectoral 16, body depth 22.5, least depth of caudal peduncle 15, head 31, postorbital 18, head depth directly behind eye 15, head width at same point 20, maxillary 13, snout 9, eye 5.5, interorbital 10.5, antedorsal distance 36.5. Color brownish, dark on dorsal aspect, much lighter below; no saliently distinctive markings, pigment somewhat concentrated on upper part of pectoral base forming a rather faint, diffuse blotch.

Holotype.—U.S.N.M. no. 123230. Miraflores Locks, Panama Canal; east chamber; A. O. Foster; April 28–29, 1937; female 90 mm in standard length, the caudal damaged.

Remarks.—Only one species of this genus was known heretofore, *G. guavina* from the western Atlantic coasts. The new species differs at a glance in having a strikingly short ventral fin, which also shows up well after measuring, 10 specimens of *guavina* having the ventral 18–19.5. This species also has a shorter pectoral and antedorsal, but these differences are not as great as that of the ventral; in the same 10 specimens of *guavina*, pectoral 20.5–22, antedorsal 39.5–41.5. It also has one ray less in the dorsal (in the specimens examined of *guavina*, the dorsal rays are constantly 11), and it further differs in having the preopercular sulcus naked instead of scaled over.

This is most probably a hitherto undiscovered Pacific species, corresponding to the Atlantic *guavina*, which has found its way into the Panama Canal.

Gobiomorus polylepis, n. sp.

D 6; 10. A 10. P 18. Sc 77–78. Caudal 24.5, ventral 18.2–18.4, pectoral 17.8–18, depth about 20 (belly collapsed and not accurately determinable), peduncle 11.5–12, head 30–30.5, postorbital 18–18.1, head depth 12.3–12.4, head width 14.7–14.8, maxillary 12.5–13, snout 9.5–10, eye 3.4–3.8, interorbital 7–7.5, antedorsal 36.5–37. Irregularly shaded, without distinctive markings (perhaps faded from long immersion in preservative); pectoral, caudal and the two dorsals with rows of small diffuse spots.

Holotype.—U.S.N.M. no. 130917. Colima, Mexico; exhibited by Mexican Government at Chicago World's Fair, 1893; female 277 mm, 222 mm in standard length.

Paratype.—U.S.N.M. no. 123233; from same container as the type; female 243 mm in standard length with caudal end broken off, approximately 303 mm in total length.

Remarks.—Two common and widespread species of *Gobiomorus* were known heretofore, *maculatus* from the Pacific drainage and *dormitor* from the Atlantic drainage. In preparing a revision of the genus, *polyelpis* was compared with 257 specimens of *maculatus* from localities ranging from the Gulf of California to Peru, including 14 specimens from the coast of Mexico, and 204 specimens of *dormitor* ranging from Texas to Venezuela. This is a strongly marked species and is easily distinguishable from the two common species by the number of scales. In 175 specimens of *dormitor* the range of the scale count is 58–64, in 241 specimens of *maculatus* the range is 54–60, as compared with 77–78 in *polylepis.* In the number of anal and pectoral rays, *polylepis* nearly agrees with the Atlantic *dormitor*, rather than with the Pacific *maculatus*, and in the number of scales it is also nearest *dormitor*. It is remarkable that such a sharply defined and large gobioid species from the North American continent escaped detection up to now. It is probably another one of those species having a narrowly circumscribed geographic range.

Erotelis smaragdus civitatum, n. subsp.

D 6; 12. A 10. P 17. Sc 105. Scales on dorsal aspect extending to within a short distance of eyes; opercle entirely scaleless; cheek almost naked, only a few scales present posteriorly near its middle; all scales cycloid. Preopercular spine rather reduced and concealed under the skin. Caudal 27.5, ventral 13, pectoral 15.5, depth 15, peduncle 10, head 20.5, postorbital 13.5, head depth 9, head width 9.5, maxillary 7.5, snout 4.2, eye 3.2, interorbital 4.3, antedorsal 32.5. Color almost uniformly dusky, darker on dorsal and somewhat lighter on ventral aspect; pigment somewhat concentrated on upper part of pectoral base to form a diffuse blotch; otherwise no distinctive color marks.

Holotype.—U.S.N.M. no. 123229. St. Vincent Island, Fla.; taken with seine in deep soft mud in large pond on the bay side of the island; Isaac Ginsburg; July 23, 1932; female 123 mm.

Remarks.—The above description is drawn from the holotype. Two small specimens 46–57 mm from Harbor Island, Tex., collected by John C. Pearson, have the following counts: D 6; 12. A 10. P 18. and D 6; 11. A 10. P 17.

This subspecies differs from *smaragdus* chiefly in the number of dorsal rays. In 26 specimens of *smaragdus* the dorsal rays number 11 in 25 and 10 in 1. In 11 specimens of the Pacific *armiger* the dorsal rays number 13 in 9 and 12 in 2. The dorsal count in *civitatum*, 12 in 2 specimens and 11 in 1, is intermediate between *smaragdus* and *armiger*. While only 3 specimens of *civitatum* are available, fair composite samples of *armiger* and *smaragdus* were examined to show that it diverges at least subspecifically from the latter. The samples examined indicate a divergence of subspecies degree. In general appearance, *civitatum* is not as excessively slender as *smaragdus* which is almost anguilliform, but somewhat approaches in this respect the species of the closely related genus *Eleotris*. This difference is rather marked on direct comparison of specimens, but does not show up well in measurements.

Of the 26 specimens of *smaragdus* examined 7 are from Key West, the others are from Cuba, Haiti, Puerto Rico, Curaçao, Panamá, and Venezuela. Consequently the Key West population of *smaragdus* is nearer to those of the West Indies and Central America than to that on the northern Gulf coast of the United States.

Chriolepis tagus, n. sp.

D 7; 12. A 11. P 19. Anterior part of body naked, posterior part scaled, scales extending forward to under end of first dorsal; caudal base with modified scales. (The single specimen described is in but indifferent condition, the squamation especially is defective and nearly all scales have fallen. The scale pockets indicate the extent of squamation. On the caudal base only one scale is now remaining, at its outer angle, a conspicuously modified, large ctenoid scale, very similar to the scale present in *Chriolepis minutillus* in the same position.) Lower jaw with two inner posterior caninoids. Eye large, the interorbital narrow. Ventral falling considerably short of anus. Pectoral reaching beyond a vertical through origin of first dorsal. Tongue moderately emarginate. (Color apparently faded, only a few large scattered chromatophores on head.)

Holotype.—U.S.N.M. no. 123232. Tagus Cove, Albemarle Island, Galápagos Archipelago; dredged in 10–18 fathoms; Hancock Expedition, W. L. Schmitt; January 15, 1934; male 16.3 mm in standard length, 21 mm to end of partly broken caudal.

Remarks.—The squamation is more extensive in this species than in any known species of *Chriolepis*. The number of anal and pectoral rays is higher than in any other species. The number of dorsal rays is higher than in any species, except some individual variants of *minutillus*. Altogether, *tagus* is a sharply divergent and strongly marked species.

Chriolepis benthonis, n. sp.

D 7; 9. A 8. P 16. Anterior part of body naked, posterior part scaled; scales extending forward to a point near midline under base of seventh dorsal ray; in 12 oblique rows to base of caudal; a few scales on posterior part of peduncle ctenoid, most scales cycloid; modified scales on caudal base present (most modified scales missing and cannot be described in detail). Lower jaw without posterior inner caninoids. Eye very large; interorbital very narrow. Ventral reaching anus. Pectoral reaching to under base of first dorsal ray. Tongue entire. Ventral 28.5, pectoral 27.5, depth 21, peduncle 12, head 30.5, postorbital 14.5, head depth 17, head width 19, maxillary 12, snout 8, eye 10.5, interorbital 2, antedorsal 37.5. (Color a rather uniform light yellowish, probably faded.)

Holotype.—U.S.N.M. no. 47641. *Blake* Expedition, station CCXLI, Alexander Agassiz; off Progreso, Yucatán, Mexico; lat. 23° 13′ N., long. 89° 10′ W.; 84 fathoms; male 30.7 mm in standard length, the caudal damaged.

Remarks.—This species has the lowest number of dorsal and anal rays of any known species of *Chriolepis*. The extent of scalation is nearly as in the Pacific *zebra*; it differs from that species, besides the difference in the number of dorsal and anal rays, also in having smaller teeth, a larger eye and narrower interorbital.

Psilotris, n. gen.

Genotype.—*Psilotris alepis*, n. sp.

This genus is characterized by and differs from all known American eleotrid genera, by a combination of two characters: the total lack of scales and the absence of mucous pores. Full grown specimens of *Eleotrica* also lack scales; but *Psilotris* differs in lacking pores as well. A detailed study of American gobioids leads to the conclusion that the character of the pores is more important as a phylogenetic criterion than the character of the squamation. It follows then that *Psilotris* is more nearly related to *Chriolepis* which also lacks pores, although the latter has the body partly scaled. With respect to the squamation, and other characters as well, *Psilotris* and *Chriolepis* present a closely analogous, parallel development to the genera *Gobiosoma* and *Garmannia* in the family Gobiidae.

Etymology.—*Psilotris*, an abbreviated form of psiloeleotris (naked eleotris).

Psilotris alepis, n. sp.

D 7; 10. A 9. P 15. Scales altogether absent, on caudal base as well as on the body and head. Body moderately elongate, compressed; head moderately depressed. Maxillary ending under anterior margin of pupil. Mouth subterminal, lower jaw but slightly projecting; gape very moderately inclined, a horizontal through distal margin of upper lip passing through lower part of eye. Teeth in bands; outer teeth well enlarged; inner posterior teeth in lower jaw also enlarged, but hardly large enough to be described as caninoid. Ventral falling considerably short of anus; pectoral slightly short of a vertical through base of first dorsal ray. Gill opening restricted, attachment of branchiostegal membrane near lower part of pectoral base. Female anal papilla large, thick, globose. No mucous pores on head. Caudal 27.5, ventral 23.5, pectoral 27.5, depth 23.5, peduncle 13.5, head 30.5, postorbital 18, head depth 16, head width 17.5, maxillary 11.5, snout 7, eye 7, interorbital 3, antedorsal 42.5. (Because of the very small size of the specimen measured, and the comparative crudeness of the instrument used, an ordinary Vernier caliper, the preceding measurements are rough approximations only.) Diffusely cross-banded; body with 5 broad, irregular, diffuse bands, the anterior 2 somewhat Y-shaped; a subvertical, diffuse band under anterior part of eye; a wider, oblique band under posterior part of eye.

Holotype.—U.S.N.M. no. 123231. St. Croix Island, Virgin Islands; on reef; Smithsonian Hartford Expedition, W. L. Schmitt; April 8, 1937; female 17 mm. The small specimen examined appears to be an adult. It apparently represents a very small species, rather than the young of a larger species.

This species is readily distinguished from all known western Atlantic eleotrids by its total lack of scales. Its relationship is discussed above under the genus account.

Family GOBIIDAE

Genus **Gobionellus** Girard

Since my revision of this genus was published (Bull. Bingham Oceanogr. Coll. **4** (art. 2). 1932), I had the opportunity to study many more samples of nearly all species, comprising for most species many more specimens than those forming the basis of the revision. Besides the additional specimens examined, characters hitherto generally neglected and not considered in the revision, have been studied in detail. The more striking results of this study of additional samples and characters are as follows: (1) Two new species were discovered. (2) It was concluded that two American species, previously described and referred to *Euctenogobius,* are more properly placed in *Gobionellus* as their character pattern, in general, fits in well with the other species of the latter genus. (A discussion of the status of *Euctenogobius* has been published by me in Proc. U. S. Nat. Mus. **82:** 19. 1933.) (3) The relationship of one species as treated in the revision, needs emendation. The two new species are here described, and also three new subgenera are established, in accordance with the additional information to place all species in their proper place in the scheme of classification employed in the revision.

Gobionellus mystax, n. sp.

D 6; 13. A 14. P 17–19. Sc 70–73. Scales extending on antedorsal area to a vertical plane through preopercular sulcus, a narrow naked area on midback, corresponding to predorsal keel, extending from origin of first dorsal, all the way forward; dorsal area in front of preopercular sulcus, and side of head scaleless; throat largely naked, except a rather narrow longitudinal median strip of scales; pectoral base scaleless; ventral aspect of belly scaled, except a rather moderate naked area directly behind base of ventral fin; anterior scales and those on belly cycloid, posterior scales nearly all ctenoid, the ctenoid scales beginning at a point near midline under base of fourth dorsal spine. Teeth in narrow bands, those in outer and inner rows only a little larger than others. Second and third dorsal spines in male notably prolonged, the third longest, reaching base of fifth dorsal ray. Maxillary notably long, its end reaching preopercular margin or nearly so. Caudal 55.5–57.5, ventral 20.5–21, pectoral 19, depth 16–17, peduncle 9–9.5, head 22, postorbital 10.5–11, head depth 13, head width 11–11.3, maxillary 15.5–16, snout 8–8.5, eye 4.5, interorbital 3.5–4, antedorsal 29. (Color dark all over without distinctive markings, probably the color pattern obliterated from long immersion in preservative.)

Holotype.—U.S.N.M. no. 130859. Laguna de Mexcaltitan, Territory of Tepic [now the state of Nayarit], Mexico; exhibited by Mexican Government at Chicago World's Fair, 1893; male 227 mm, 144 mm in standard length.

Paratype.—U.S.N.M. no. 123235. In same lot with the type; male 251 mm, 161 mm in standard length.

Remarks.—This species is close to *microdon* and belongs in the same subgenus with it, *Gobatus.* It differs in having a longer maxillary and caudal. In the genus *Gobionellus* both of these characters differ with the species and also intraspecifically with sex and size, the caudal considerably and the maxillary moderately so. As the two specimens examined are very large males, it may be suggested that the seemingly specific differences are rather due to their size and sex. However, they were compared with a male of *microdon* 117 mm in standard length from Miraflores Lake, Panama Canal, not much smaller than the two specimens here described, and the differences in these two characters are too pronounced to be reasonably ascribed to intraspecific individual variability or sex and size differences. They are evidently interspecific differences and the two specimens represent a species close to but different from *microdon.* In the above male of *microdon*: caudal 34; maxillary 12.5, ending under posterior margin of eye. The maxillary in *mystax* is so strikingly long that the generic definition given in my revision of the genus needs to be emended to include this species.

The scales in the two specimens of *mystax* number 70–73, while in the two types of *micro-*

don from Río Ahome, México, they number 60–61, and it would seem that the two species also differ in the scale count. However, in two specimens of *microdon* from Río Juan Diaz, Panamá, the scales are 59–65, while in two from the Panama Canal they number 69–72. Consequently, the scale count in *microdon* seems to differ intraspecifically with the population, and its possible value as an interspecific character remains to be determined by more extensive samples.

Gobionellus gracillimus, n. sp.

D 6; 14. A 15. P 18–20. Sc 83–99. Antedorsal area completely scaled to within a short distance of eyes; opercle with a moderate-sized patch of scales at upper anterior corner; cheek naked or a few scales present; throat partly scaled; pectoral base scaleless; ventral aspect of belly scaled over posteriorly, a rather large or moderate sized area behind base of ventral fin naked; anterior scales cycloid, posterior scales mostly ctenoid, the ctenoid scales beginning at a point variably situated under base of third dorsal spine to under base of fifth dorsal ray. Teeth in narrow bands, those in outer and inner rows a little larger than those in between. Maxillary generally ending under space between posterior margin of pupil and that of eye, slightly past eye in the largest males. Second to fourth dorsal spines notably prolonged in large specimens, the longest spine usually reaching to base of fifth or sixth dorsal ray, sometimes to base of third ray. Body notably slender and caudal notably long; depth 11.9–15.5 in female, 11–13.3 in male; caudal 41–46.5 in female, 51.5–63.5 in male. Other measurements not of paramount specific importance and only slightly or moderately different with sex, the range of both sexes as follows: ventral 17.5–21.5, pectoral 16.0–20.5, peduncle 7.5–9, head 18–21.5, postorbital 8.5–11.5, head depth 10.5–13, head width 9–10.5, maxillary 9.5–11.5, snout 6.5–7.5, eye 3.5–5, interorbital 2–3, antedorsal 25–29.5. (All preceding measurements, including that of caudal and depth, of specimens 106–165 mm in standard length.) A large, longitudinally oblong, dark spot below first dorsal and centered slightly above middle of body; a small spot on caudal base; 2 or 3 small dark spots on anterior margin of first dorsal; a median longitudinal row of many small spots, well marked in a recently preserved specimen, now faded, and not discernible in other preserved specimens; the large body spot and the caudal spot rather well marked in the smaller specimens, faint or imperceptible in large ones (color pattern seemingly becoming faint with growth and also fading in preserved specimens).

Holotype.—U.S.N.M. no. 123227. Apalachicola Bay, Fla.; trawl; July 16, 1932; Isaac Ginsburg; male 271 mm, 165 mm in standard length.

Remarks.—Thirteen other specimens 106–157 mm in standard lengths were studied from St. Johns River, New Smyrna, and Pensacola Bay, Fla.; Bayou St. Denis, La.; off Padre Island, Tex.

In the revision of the genus, the populations of the extremely long bodied, western Atlantic gobies which belong to the subgenus *Gobionellus*, were divided into two species on the basis of the scale count, *hastatus* with more numerous scales from the northern Gulf coast, and *oceanicus* with fewer scales from Key West, the West Indies, and Central America. On the basis of the samples examined for the revision of the genus, the two species showed both a morphologic and geographic gap between them. Hildebrand and Cable later found that their geographic ranges overlap and that both species occur at North Carolina (Bull. U. S. Bur. Fish. **48:** 365. 1938). By an examination of many more specimens, I now find that these two species also intergrade somewhat in the scale count and are not as easily separable as the smaller samples indicated. Furthermore, I now find that the finer scaled gobies from the coast of the United States (58 specimens were now examined instead of the 7 specimens examined for the revision), fall into two groups, rather roughly separable by four correlated characters. One group, here distinguished as *gracillimus*, has a longer caudal, more slender body, longer dorsal spines and more numerous scales. The data for the four characters seem to form four bimodal curves, and we are evidently dealing with two distinct populations, *gracillimus* and *hastatus*. However, they intergrade in all four characters and individual specimens cannot always be placed with certainty. If a specimen has all four, or at least three, of the characters typical or close to the mode of its population, it can be placed with a measure of assurance, and this is so with the large majority of specimens. But, if a specimen has less than three characters correlated, or if three or four of its characters fall near the borderline its proper position is doubtful. (Such doubtful specimens constitute approximately 10 percent of the total.) Consequently, the proper taxonomic status of these two evidently distinct populations is uncertain. If they were to occupy separate geographic ranges, they should properly be treated as two geographic subspecies, and such a course could hardly be questioned. As it is, they either constitute two coordinate, synpatric subspecies, in which case they form an exception to the general rule that two subspecies occupy separate territories, perhaps they are ecological subspecies having nearly the same geographic range; or they constitute two full species which are but incompletely distinguishable by current taxonomic methods. These questions might be resolved by a more elaborate sampling of the populations, perhaps supplemented by ecological studies. The distinguishing characters, except the scale count, differ also with size and sex, and hence it would take very extensive samples to work out the finer details.

Large males, 120 mm or over in standard length, diverge most, and such specimens are well separable by species.

It is probable that depth of water is a factor in the distributional basis of the separation of the two species. Detailed records of capture are wanting or incomplete for most of the constituent samples examined. But judged by the available records, it seems that *gracillimus* is usually taken with a trawl, while *hastatus* is taken with a seine as often as with a trawl. However, neither species is a real deep water fish. The greatest depth recorded is 10 fathoms for a specimen of *gracillimus* taken off Padre Island, Tex. Eight of the 14 specimens of *gracillimus* examined, comprising 5 constituent samples, were taken in Pensacola Bay and that body of water seems to be the center of distribution of the species.

Gobidus, n. subgen.

Genotype.—Gobionellus longicaudus (Jenkins and Evermann) = *Gobius longicaudus* Jenkins and Evermann.

Before this subgenus is characterized, two new symbols are herewith proposed to be used for two mucous pores placed over the opercle. In Sanzo's (Mitth. Zool. Stat. Neapel **20:** 251–328. 1911) system of symbols for the various parts of the lateral line organs of gobies, the anterior and posterior pore which form the openings of the mucous channel over the opercle, are designated as ρ' and ρ'', respectively. His symbols for these pores are rather cumbersome, somewhat confusing, and to a certain extent misleading in that those two pores are often present or absent independently of ρ, at least I find it so in the American species. The symbols θ and τ are, therefore, here proposed to designate the anterior and posterior pore, respectively.

Extreme groups of species of *Gobionellus* are sharply distinguished by three striking characters, in addition to others. Those of the subgenus *Gobionellus* have a notably long and slender body, small scales, and they possess θ and τ; while those of *Gobica* have a body more like the usual gobiid shape, large scales and they lack θ and τ. The subgenus *Gobidus* lacks θ and τ like *Gobica*, its scales are nearly as in *Gobionellus*, while the body shape is rather intermediate or nearer to *Gobionellus*. Its dorsal spines are not at all prolonged and shorter than in any other subgenus, except *Congruogobius*. In the revision, the species of this subgenus was included with *microdon* in the subgenus *Gobatus*, largely on the basis of the scale and fin ray counts. However, the latter has θ and τ, and in other characters as well is much nearer the subgenus *Gobionellus*. *Gobidus* essentially agrees with *Gobica* in the lateral line organs and the color pattern, and in spite of superficial appearances, it is nearer to that subgenus than to *Gobatus*.

Gobionellus longicaudus has generally been placed by authors in the synonymy of *sagittula*, and in the revision of the genus I disposed of that name in the same manner; but the study of additional samples and characters show that the Mexican *longicaudus* and the Panamanian *sagittula* diverge markedly in the number of pectoral rays (a character not studied in detail in the revision) and scales, although they intergrade to some extent and may perhaps be treated as coordinate geographic subspecies. Without a definite commitment as to the taxonomic rank of *longicaudus* for the present, I prefer to designate it as the genotype of *Gobidus* because I have examined the type specimens and am certain of its position, while *sagittula* I identify only from its description.

Gobatinus, n. subgen.

Genotype.—Gobionellus panamensis (Meek and Hildebrand) = *Euctenogobius panamensis* Meek and Hildebrand.

This subgenus also is in a sense intermediate between the two groups noted above in that it has a combination of important characters of both groups, but in a manner reverse from that of the subgenus *Gobidus*. The scales are large (34–37) as in *Gobica*, while it has θ and τ like *Gobionellus*. The body shape is intermediate between that of the last two named subgenera. *Gobatinus* has the teeth in the upper jaw usually in one row, sometimes a second incomplete inner row is present. In the other subgenera, the teeth in the upper jaw are in 2–5 rows, depending on the subgenus.

Congruogobius, n. subgen.

Genotype.—Gobionellus liolepis (Meek and Hildebrand) = *Euctenogobius liolepis* Meek and Hildebrand.

This subgenus differs from all others in having the two dorsal fins confluent and the scales cycloid, except that the scales on a narrow strip along a median area on the posterior part of the body are weakly ctenoid or cycloid. In these two characters it is somewhat intermediate between the genera *Gobionellus* and *Gobioides* but much nearer the former. Indeed, *Gobionellus* and *Goboides* are nearer in relationship than has been heretofore suspected. This is shown not only by the somewhat intermediate positions occupied by the subgenus *Congruogobius*, but by other characters as well, especially by the lateral line organs, a discussion of which would take us too far afield here. The scales in *Congruogobius* are 77–84; θ and τ are present. In the latter two characters, as well as in the shape of the body and the number of fin rays, it nearly agrees with or is nearest to the subgenus *Gobionellus*. The interorbital is rather wide as in the subgenus *Gobionellus*, while the eye is even smaller than in that subgenus when specimens of the same size are compared. In the latter two characters it also somewhat approaches *Gobioides*.

MALACOLOGY.—Amnicola brandi, *a new species of snail from northwestern Chihuahua*.

Robert J. Drake, Biblioteca y Museo de Sonora, Hermosillo, Sonora.

(Communicated by Joseph P. E. Morrison.)

In the middle of April 1949, the writer was in northwestern Chihuahua with Prof. C. Clayton Hoff, of the Department of Biology of the University of New Mexico. At that time, Dr. Hoff was the recipient of a grant-in-aid from the United States Public Health Service for collecting and studying ectoparasites (fleas and lice) of rodents in northern Chihuahua and southern New Mexico. During this trip, at Las Palomas, Distrito Galeana, Chihuahua, the type material of the species of fresh-water amnicolid snail here described was collected. The Las Palomas region is the type locality of another amnicolid, described as *Bythinella palomasensis* by Henry A. Pilsbry (1895: 68–69; Dall, 1898: 369–370). He based his description on two dead shells that had been collected in April 1892 by Edgar A. Mearns, military medic and naturalist of the International Boundary Commission of the United States and Mexico. Mearns, assisted by Frank X. Holzner, made daily collecting visits to Lake Palomas during the period from April 7 to April 15, 1892. (Mearns, 1907: 10). In the description of *Bythinella palomasensis*, Mearns's locality was given as merely at "Lake Palomas, northeastern [sic] Mexico."

Lake Palomas in northwestern Chihuahua, as it normally existed in the later 1800's, is no more. Then it consisted of a chain of shallow and marshy ponds connected by a small running stream, all of which terminated in a more or less broad and shallow permanent lake. The area of the old lake bed now fills with water only during the short rainy season; otherwise, it is a dusty and waterless flat.

The small town of Columbus, Luna County, N. Mex., is on the border. The small Mexican port-of-entry and customs station at Palomas, Chihuahua, is 1 mile south of Columbus. Las Palomas is a small collection of adobe houses 6 miles south of Palomas and the border. It is at Las Palomas, Chihuahua, that "some fine, bold springs" as noted in the International Boundary Commission report (1898, pt. II: 16) are located. The species of Amnicolidae described, lives in the Las Palomas springs with another amnicolid (undetermined, perhaps a *Lyrodes*), the common pea-clam *Pisidium abditum* Haldeman, and a form of the everpresent *Physa*. No shells belonging to the present new species were found that remotely resemble the single illustration of the moderately high and narrow *Bythinella palomasensis* Pilsbry (Dall, *loc. cit.*, pl. 31, fig. 9).

The region was very dry at the time of our 1949 trip; no land shells were found alive or aestivating. Some shells were gathered from the *rejectamenta* of the Rio Casas Grandes at the Vado de Fusiles about 30 miles due south of Palomas and the border. They will be reported on in time.

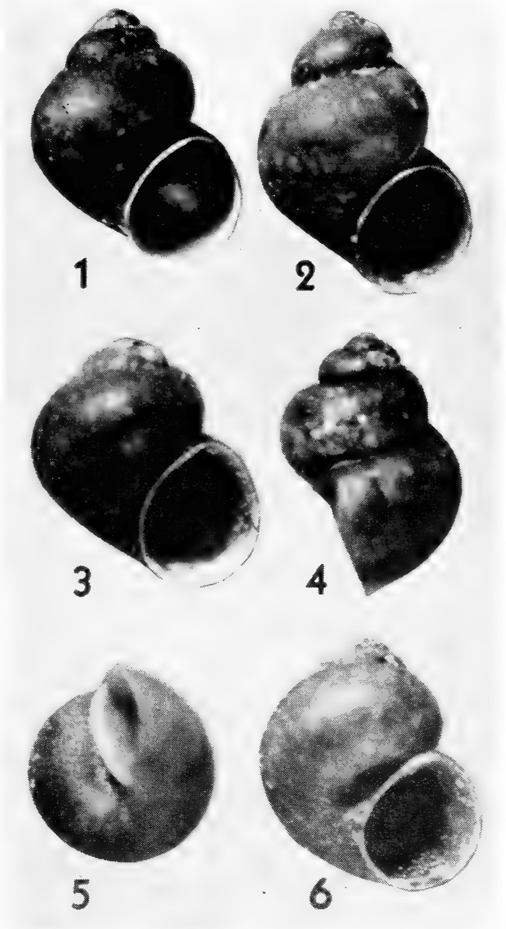
Dr. Harald A. Rehder, curator, Division of Mollusks, U. S. National Museum, kindly provided illustrations of the type material for this paper. Dr. Joseph P. H. Morrison, of the same division, gave much help in many ways.

Amnicola brandi, n. sp.
Figs. 1–6

Holotype.—The shell is white, under average size for genus, and globose. The spire is short and rounded; the protoconch is elevated and slightly eroded. The umbilicus is deeply perforate and narrow. The surface exhibits very faint growth wrinkles. There are 3.9 whorls which are convexly inflated and have some shouldering at the moderately impressed sutures. The aperture is oval, wider than high; its height and width equal about half the height and width of the entire shell. The inner lip flares slightly, is very white, and its callus forms a rounded rim on the side next to the umbilicus. The holotype (U.S.N.M. no. 601494) measures: length, 2.2 mm; width, 1.8 mm; aperture length, 1.0 mm; aperture width, 1.0 mm. It was collected by C. Clayton Hoff and Robert J. Drake, on April 15, 1949, in springs at Las Palomas, Chihuahua.

This species is named in honor of Dr. Donald D. Brand because of his long period of active interest in the geography, archeology, and natural history of northern Mexico—especially that of northwestern Chihuahua. Brand's archeological writings are so steeped in geographic description that his works on northwestern Mexico are indispensable references for naturalists and anthropologists interested in study of the area (see especially Brand, 1935, 1936, 1937, 1943).

Paratypes: The five descriptional paratypes (U.S.N.M. no. 601495) are illustrated (Figs. 2–6). About 200 paratypes were collected. They have been deposited as follows: Wendell O. Gregg Collection, 5132; Academy of Natural Sciences of Philadelphia, 185402; Ernest J. Roscoe Collection, 295; Morris K. Jacobson Collection, 2257; Department of Paleontology of the California Academy of Sciences, 32878; Allyn Hancock Foundation of the University of Southern California, 1230; Carnegie Museum, 62.39827; Chicago Natural History Museum, 32001; Museum of Zoology of the University of Michigan, 169876; Drake Molluscan Collection, 1459, 1460; Museum of Comparative Zoology, 185251; Department of Geology Museum of the University of New Mexico, 1347; Elmer G. Berry Collection; Laboratory of Conchology of the Biblioteca y Museo de Sonora; Stanford University Paleontological Type Collection, 8025;



FIGS. 1–6.—*Amnicola brandi*, n. sp.: 1, Holotype (U.S.N.M. no. 601494): 2–6, paratypes (U.S.N.M. no. 601495).

American Museum of Natural History, 72857; S. S. Berry Collection; Joshua L. Baily, Jr., Collection; Museum of Paleontology of the University of California, 36121–36129; San Diego Society of Natural History; Allyn G. Smith Collection, 9027; Hans Friedrich Collection, 9936; U. S. National Museum, 600499, 600500.

Discussion.—*Amnicola brandi* is a species that is small in size when compared with most of the amnicolids of the eastern United States and Canada. This feature is shared in common by all Southwestern Amnicolidae. Consistency of characters is evidence for long isolation and "inbreeding" for the species. Dr. Joseph P. E. Morrison (1949) has presented a classification of the subfamilies of the Amnicolidae based primarily on reproductive features. These four subfamilies are: Hydrobiinae, Bythinellinae, Buliminae, and Emmericiinae. Dr. Morrison has examined the male organs of some of the preserved paratypes of *Amnicola brandi*. He reports *brandi* has only one functional duct in the male reproductive system. Therefore the species is placed generally in the Hydrobiinae. (The operculum is paucispiral with the concave side next to the animal.) The genus of *brandi* is closest to what is considered *Amnicola* s. s. In time, a new generic category may have to be established for *brandi*. To do so now and before Morrison's results of many years of study with the family are available to all concerned would only be confusing. Many species that have been placed in *Amnicola* very probably belong in "*Amnicola*" and consequently in any of the subfamilies now recognized as biological.

LITERATURE CITED

Brand, D. D. *The distribution of pottery types in northern Mexico.* Amer. Anthrop. n.s., **37:** 287–305. 1935.

———. *Notes to accompany a vegetation map of northwest Mexico.* Univ. New Mexico Bull., biol. ser., **4** (4). 1936.

———. *The natural landscape of northwestern Chihuahua.* Univ. New Mexico Bull., geol. series., **5** (2). 1937.

———. *The Chihuahua culture area.* New Mexico Anthrop. **6–7:** 115–138. 1943.

Dall, W. H. *Report on the mollusks collected by the International Boundary Commission of the United States and Mexico, 1892–1894.* Proc. U. S. Nat. Mus. **19:** 333–379. 1896.

International Boundary Commission. *Report of the Boundary Commission upon the survey and re-making of the boundary between the United States and Mexico west of the Rio Grande, 1891 to 1896.* Parts I, II, atlas. Washington, 1898.

Mearns, E. A. *Mammals of the Mexican Boundary of the United States.* U. S. Nat. Mus. Bull. 56, pt. I. 1907.

Morrison, J. P. E. *The cave snails of eastern North America.* Amer. Malacol. Union News Bull. and Ann. Rep. for 1948: 13–15. 1949.

Pilsbry, H. A. *A new Mexican* Bythinella. Nautilus **9:** 68–69. 1895.

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MYCOLOGY.—*Three new species of* Conidiobolus *isolated from leaf mold.*

Charles Drechsler, U. S. Department of Agriculture, Plant Industry Station, Beltsville, Md.

Recently I reported (Drechsler, 1952) that *Delacroixia coronata* (Cost.) Sacc. & Syd., a saprophytic entomophthoraceous fungus which earlier was encountered only rarely by mycologists and was generally presumed to be very meagerly distributed, is in fact virtually ubiquitous on leaf mold and other vegetable materials undergoing slow decay in moist contact with the ground. Separate cultures of the fungus, free of alien organisms, are with little effort obtainable in large numbers from isolation plate cultures prepared by fastening portions of decaying plant detritus with soft agar in a central area on the ceiling of each Petri dish. The soft agar employed not only serves as an adhesive matrix securely holding all particles of detritus in a canopylike layer about 10 mm above the layer of sterile agar on the floor of the Petri dish, but also supplies moisture to all detritus particles and thereby encourages prompt germination of any conidia or resting spores that may be present. Since in *D. coronata* either repetitional or mycelial development soon leads to formation and violent discharge of new conidia, macroscopically discernible mycelia of this fungus are commonly found growing in a maizemeal-agar plate within 48 hours after the canopy of leaf mold has been superposed. From the regularity with which *D. coronata* develops in canopied agar plates, even though only 0.2 to 0.3 gram of leaf mold is used in each Petri dish, it would seem beyond question that this fungus must exist in our middle and northern latitudes more abundantly than any of the numerous conspicuously insectivorous species through which the Entomophthoraceae have long been familiar.

The frequently early appearance of *Delacroixia coronata* in canopied plate cultures, together with its rapid growth, its prompt production of numerous conidia, and the forceful projection of these conidia over adjacent areas, makes more difficult the detection and isolation of less vigorous entomophthoraceous fungi likewise commonly present in leaf mold and other slowly decaying residues. Mainly for this reason few cultures referable to *Conidiobolus* were obtained from several dozen of the first canopied agar plates I prepared with leaf mold from different localities in Maryland and Virginia. The difficulties consequent to excessively close seeding of the conidia on the sterile substratum were later obviated with fair success by leaving agar plates exposed to conidial discharge for only a few hours, especially during the third and fourth days after the canopy had been prepared. Conveniently sparse seeding was obtained by removing the lid and its adhering canopy at successive intervals to a new bottom containing a newly poured plate of sterile maizemeal agar, each agar plate after exposure being immediately covered with a sterile lid. After 6, 8, or 10 hours, when some of the scattered conidia had grown out vegetatively, the resulting mycelia could be detected readily by examining the agar surface with the naked eye by reflected light. Through early removal of the young mycelia to sterile maizemeal agar slants plenteous collections of pure cultures were obtained; in these were included, besides *D. coronata* and some almost equally vigorous entomophthoraceous species, a number of related species less obtrusive because of their slower growth and feebler conidial propulsion.

Most of the entomophthoraceous fungi thus isolated seem best assignable to the genus *Conidiobolus* erected by Brefeld (1884) primarily on his *C. utriculosus*, a robust species that made its appearance adventitiously in nutrient solution he had placed under fruiting bodies of *Hirneola* and *Exidia* for the purpose of germinating discharged basidiospores. From the scale of magnification indicated for the relevant figures, the disjunctive mycelial hyphae of this species seem to vary from 10 to 20μ in width. Its globose zygospores are stated to measure 60 to 100μ in diameter. Its conidia are described as being pear-shaped, with a length of 50μ and a width of 35μ. Although such large dimensions should help to invite notice, *C. utriculosus* has apparently not been recorded again at first hand since its description 68 years ago. Brefeld also reported as occurring on some "Tremellinen" a second species of *Conidiobolus* with conidia he stated to be scarcely one-third as large as those of *C. utriculosus*. The few illustrations he gave of these smaller spores show lengths varying from 20 to 23μ and widths varying from 14 to 15μ. Since in his material the smaller species always became overgrown at an early stage by the more vigorous *C. utriculosus* he was unable to cultivate it separately, and only rather provisionally named it *C. minor*. No additional first-hand report of this tentative species is known. In view of the circumstances under which it was observed its distinctness from *C. utriculosus* is open to serious doubt, for in all fairly robust species continued repetitional development leads to marked reduction in conidial size and indeed often brings about dimensional differences more pronounced than the differences noted by Brefeld. On the other hand, if the assemblage of entomophthoraceous fungi I have so far isolated from decaying plant detritus is at all representative, species with relatively small primary conidia are more numerous than species rivaling *C. utriculosus* in the size of their asexual spores.

Nevertheless, a saprophytic member of the Entomophthoraceae that appears even more robust than *Conidiobolus utriculosus* was obtained by Gilbert (1919) from fern prothallia grown in water cultures or on moist sphagnum. The large globose primary conidia of this fungus, which are described as measuring 48 to 60μ in diameter, would seem alien both to *C. utriculosus* and to *Delacroixia coronata*. The propulsion of these conidia often for a distance of 65 mm bespeaks a discharge mechanism several times more powerful than any mechanism operative in the different species of my collection. As Gilbert's account makes no mention of hirsute resting spores or of any production of small conidia on multiple short outgrowths extended from large conidia, the fungus may eventually find a place in Brefeld's genus. Apparently it has not been reported again during the 33 years since it was first made known and has not hitherto appeared among my cultures.

More recently Couch (1939) fully described under the binomial *Conidiobolus brefeldianus* a readily culturable entomophthoraceous fungus he obtained as a contaminant in an agar plate that had been exposed to spore discharge from a fruiting layer of *Septobasidium apiculatum* Couch on *Cornus amomum* Mill. From *Conidiobolus utriculosus*, with which it makes up the meager established membership of the genus, this fungus differs by its generally smaller dimensions—the width of its hyphae being given as varying from 5.4 to 8μ, the thickness of its spherical conidia as varying from 10 to 31μ, and the diameter of its zygospores as varying from 18 to 33μ. Canopied agar plate cultures prepared with plant detritus taken from localities near the District of Columbia during the winter of 1951–52 have not yielded *C. brefeldianus*, but the species has come forth abundantly in cultures prepared with small quantities of some dry plant detritus which W. F. Jeffers kindly collected early in July 1951 in woods near Tampa, Fla., and near Statesboro, Ga.

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MYCOLOGY.—*Three new species of* Conidiobolus *isolated from leaf mold.*

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Recently I reported (Drechsler, 1952) that *Delacroixia coronata* (Cost.) Sacc. & Syd., a saprophytic entomophthoraceous fungus which earlier was encountered only rarely by mycologists and was generally presumed to be very meagerly distributed, is in fact virtually ubiquitous on leaf mold and other vegetable materials undergoing slow decay in moist contact with the ground. Separate cultures of the fungus, free of alien organisms, are with little effort obtainable in large numbers from isolation plate cultures prepared by fastening portions of decaying plant detritus with soft agar in a central area on the ceiling of each Petri dish. The soft agar employed not only serves as an adhesive matrix securely holding all particles of detritus in a canopylike layer about 10 mm above the layer of sterile agar on the floor of the Petri dish, but also supplies moisture to all detritus particles and thereby encourages prompt germination of any conidia or resting spores that may be present. Since in *D. coronata* either repetitional or mycelial development soon leads to formation and violent discharge of new conidia, macroscopically discernible mycelia of this fungus are commonly found growing in a maizemeal-agar plate within 48 hours after the canopy of leaf mold has been superposed. From the regularity with which *D. coronata* develops in canopied agar plates, even though only 0.2 to 0.3 gram of leaf mold is used in each Petri dish, it would seem beyond question that this fungus must exist in our middle and northern latitudes more abundantly than any of the numerous conspicuously insectivorous species through which the Entomophthoraceae have long been familiar.

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While canopied agar plate cultures are very serviceable in bringing to light a category of entomophthoraceous fungi that are not often encountered by chance, and in showing such fungi to be virtually ubiquitous on slowly decaying detritus, they are far less helpful than might be desired in disclosing what particular constituents of detritus samples were used as sources of nourishment. Owing to the forceful discharge of conidia by the fungi in question, and to successive repetitional development of the discharged spores, it may be presumed that during prolonged periods of rainy weather numerous constituent particles near each particle used as a nutrient substratum will become bestrewn with conidia in greater or lesser abundance. Naturally when samples of detritus are gathered before drier conditions have supervened, and portions of them are fastened soon afterwards in a moist matrix to the ceiling of a Petri plate, some of the conidia adhering to merely contaminated particles may be expected to produce and shoot off new conidia that will be no less effective in establishing mycelia on the agar below than conidia shot off from the nutrient particles themselves. It is true that if canopied cultures are prepared with detritus that has previously been exposed for several months to gradual drying, all the earliest new conidia may be expected to have their origin from the germination of resting spores, which, except in *Delacroixia coronata*, are commonly formed on the assimilative hyphae, and therefore should be present mainly in nutrient particles. Such germination, however, entails some delay, so that when the earliest new conidia fall on the agar floor the whole canopy has become so badly overgrown with alien molds that the individual particles are obscured beyond recognition.

Although the species of Entomophthoraceae readily growing in pure culture on ordinary substrata are often termed "saprophytic" they do not, as a rule, thrive well in the presence of putrefactive organisms. Even rather slight bacterial contamination often halts their vegetative development completely, and subsequently brings about degeneration of their mycelial hyphae and asexual reproductive apparatus throughout the affected area. In agar plate cultures exposed to promiscuous contamination they are often rather strongly repressed by filamentous fungi little noted for antagonistic behavior. Against generally antagonistic molds, as, for example, species of *Penicillium*, *Aspergillus*, and *Trichoderma*, they show, on the whole, very little endurance. Rather commonly when their conidia fall near such molds neither vegetative nor repetitional germination ensues, but the spores turn dark and degenerate internally.

Despite the wide assortment of filamentous fungi with which they were often intermixed in older plate cultures, none of the species in my collection have been seen attacking other molds. In view of Brefeld's statement that *Conidiobolus utriculosus* under natural conditions subsisted parasitically on fruiting bodies of "Tremellinen" occasion was taken whenever possible to observe the behavior of *Conidiobolus* mycelia when they encountered mycelia of basidiomycetes. Suitable opportunity for such observation was offered frequently in agar plate cultures that had been canopied with fine-textured debris found lodged basally between the crowded culms in old tussocks of some grasses, for in addition to conidia of *Conidiobolus* this kind of litter brought forth basidiospores that likewise were discharged early and gave rise to numerous clamp-bearing mycelia. No sign of parasitism was noted in extensive areas where the two types of mycelia were closely intermixed.

Brefeld's statement that *Conidiobolus utriculosus* subsists parasitically on fruiting bodies of "Tremellinen" was not amplified by any mention of observed abnormal changes in the fructifications harboring the entomophthoraceous fungus. Couch made no mention of any abnormality affecting the *Septobasidium* material from which he obtained *C. brefeldianus*. White (1937) did not record any unusual condition in the apothecia of *Peziza domiciliana* Cooke which when fastened above an agar plate for ascospore discharge gave him abundant growth of *Delacroixia coronata*. In these several instances of adventitious occurrence of readily culturable entomophthoraceous fungi the fruiting bodies need not have been infected, but may merely have been newly contaminated with conidia cast upon them from neighboring mycelia of the phycomycetous forms concerned. Other objects within range of spore discharge, as, for example, chunks of bark, fragments of wood, pieces of twigs, and lumps of leaf residues, could well be expected to become contaminated no less frequently than fruiting bodies of ascomycetes and basidiomycetes, but in the past have less often been superposed over nutrient solutions and sterile agar plates. Conidia adhering to them have had correspondingly less opportunity to discharge secondary conidia down upon an expanse of favorable substratum that was being kept under close observation by an alert investigator. Presumably neither newly discharged conidia nor actively sporulating mycelia are necessary in canopied plate cultures, since here the moisture in the soft agar used as an adhesive matrix encourages germination of resting spores.

A SLOW-GROWING LUSTROUS DISJUNCTIVE SPECIES WITH SMALL CONIDIA AND SMALL ZYGOSPORES

An unobtrusive species of *Conidiobolus* which in the small size of its conidia recalls *C. minor* was obtained from leaf mold collected on January 22, 1952, in woods near Fort Myer, Arlington, Va. Its isolation in pure culture was attended with some little difficulty, as its vegetative growth is slow in comparison with that of several congeneric species among which it was intermingled. When cultivated on moderately firm maizemeal agar at temperatures near 20° C., it extends its mycelium radially only about 2.5 mm in 24 hours. To the naked eye an individual young mycelium appears markedly lustrous throughout. Later as the mycelium expands the lustrous effect often diminishes in the older central region while remaining undimmed toward the sharply demarcated margin. When viewed under the microscope the hyphae in the marginal zone show a considerable degree of prallelism in their arrangement. For the most part they vary in width from 4 to 7μ (Fig. 1, A, B). Although the individual filament shows noticeable variations in width along its slightly crooked course, pronounced fluctuations in this dimension are not usual, and only rather little tapering is observable near the bluntly rounded tip. Branching at the margin of an extensive mycelium is often characterized by angular relationships usual in dichotomy (Fig. 1, B). Cross-walls are laid down fairly early, the most distal septum in a filament being often found 150 to 200μ from the tip. Vacuolization near a newly inserted cross-wall (Fig. 1, B) commonly leads to complete emptying of a short hyphal part, and as evacuated portions of hyphal membrane usually soon fade from sight many living segments appear disjointed from their fellows. Some disjointed segments later produce short diverticulate branches (Fig. 1, C) and thus acquire an irregular, somewhat lobulate outline.

Asexual reproduction takes place by development of a single conidium from the individual hyphal segment. A hyphal segment formed on the surface of the substratum pushes forth into the air and toward the main source of light an erect or ascending branch which on attaining a length frequently of 20 or 25μ (Fig. 1, D, E) swells out markedly at its tip. The terminal swelling receives all the protoplasmic contents of the hyphal segment, and is then delimited as a conidium through deposition of a convex basal wall. Hyphal segments formed in submerged positions first extend a branch or prolongation through the ambient to the surface. When the surface is reached the elongating filament grows erectly or ascendingly into the air, its course, after an abrupt (Fig. 1, F) or more gradual (Fig. 1, G, H) upward turn, being directed toward the main source of light. The aerial prolongation then develops into a conidiophore in the same way as an aerial branch from a procumbent hyphal segment. Once the globose conidium has been cut off it exerts strong pressure upon the basal septum protruding convexly upward, until the peripheral membrane ruptures circularly along the circumference of the partition. Immediately the basal wall splits into two layers, and concomitantly the distal layer is everted with such briskness through pressure of the conidial protoplast that the spore is thrown off forcibly, though the trajectory on a flat level surface may not exceed a few millimeters.

While in their small dimensions the conidia (Fig. 1, I, a–i), even without repetitional development, rather closely approach those shown in Brefeld's illustration of *Conidiobolus minor*, they seem less elongated than Brefeld's specimens, and their basal wall appears more abruptly protuberant. They are commonly filled throughout with coarsely granular protoplasm, except that the basal protuberance usually shows more nearly homogeneous texture. They do not nor-

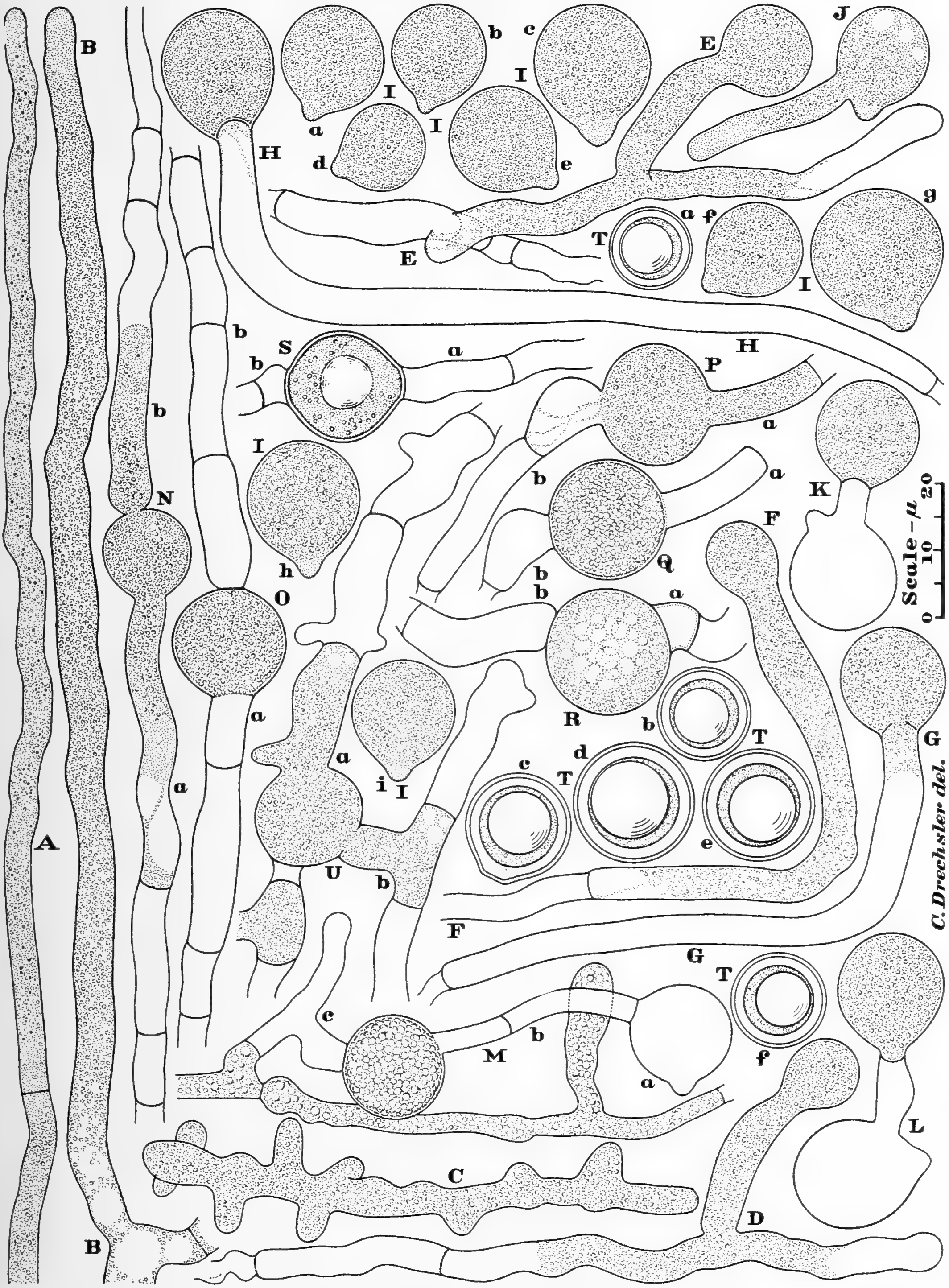

Fig. 1.—*Conidiobolus lamprauges*, sp. nov., as found developing in pure culture on Petri plates of maizemeal agar; all parts drawn at a uniform magnification with the aid of a camera lucida; × 1,000 throughout. Explanation of all parts given in text.

mally contain anything at all resembling the subspherical globules, about 3 to 5μ in diameter, shown in two conidia of *C. minor* depicted by Brefeld.

After falling on a moist substratum the discharged conidium often germinates by emission of a vegetative germ hypha (Fig. 1, J). If the substratum is already permeated with mycelium, repetitional development often ensues; the conidium putting forth a relatively short stout outgrowth on the tip of which it then gives rise to a secondary conidium (Fig. 1, K, L). The secondary conidium, like its parent, is normally delimited by a convexly arched basal partition (Fig. 1, K), and like its parent, again, is thrown off forcibly on circumscissile rupture of the peripheral membrane, abrupt splitting of the basal wall, and concomitant rapid eversion of the distal layer. In material mounted under a cover glass for microscopical examination all conidia, including those of secondary origin (Fig. 1, L), are usually not discharged after a normal manner, but commonly remain seated on the tip of the empty conidiophore, there gradually assuming their familiar proximally protuberant shape by gradually everting the entire basal septum.

Occasionally a conidium (Fig. 1, M, a) puts forth a germ tube (Fig. 1, M, b) that unites with a hyphal segment (Fig. 1, M, c) to form a zygospore. Much more often zygospores are formed through union of two hyphal segments that represent adjacent cells of the same mycelial filament. Onset of sexual reproductive development is first noticeable when one of the paired segments becomes locally swollen in the region near the crosswall separating it from its mate. The swelling increases steadily in size and soon appears as a globose enlargement. Apparently the adjoining portion of the other segment undergoes some widening at about the same time, but the increase in diameter here is usually less than 2μ, and only occasionally as much as 3μ. At a rather early stage the cross-wall separating the paired segments largely disappears, and granular protoplasm thereupon flows into the globose enlargement at both poles. Meanwhile the farther portions of both segments show increasing vacuolization, leading soon to progressive evacuation of contents. Successive stages in evacuation of the "female" segment—the segment (Fig. 1, N, a; O, a) within which the globose enlargement, or young zygospore, is formed—as well as of the "male" segment (Fig. 1, N, b; O, b) is frequently marked by deposition of a series of retaining walls. Transfer of protoplasm from the two segments is usually completed at nearly the same time, though in many instances the "female" segment (Fig. 1, P, a) appears somewhat slower than the "male" (Fig. 1, P, b) in contributing the last installment of its contents. As a rule the portions of membranous envelope successively evacuated soon collapse and vanish from sight, so that when the protoplasmic materials have migrated into the young zygospore, only relatively small membranous parts of the "female" (Fig. 1, Q, a; R, a) and "male" (Fig. 1, Q, b; R, b) segments remain visible. The portion of membranous envelope representing the "female" segment (fig. 1, S, a) shows no narrowing where it is attached, while that representing the "male" segment (Fig. 1, S, b) usually appears somewhat narrowed at its juncture with the zygospore, owing to the slight local enlargement of this segment at an early stage.

Transfer of protoplasm from the paired segments to the globose fusion cell is accomplished ordinarily in less than 2 hours. The subsequent changes in internal organization take place more slowly. By imperceptible stages the contents of the fusion cell change from a finely granular to a coarsely granular texture (Fig. 1, Q). Globules of increasing size appear near the center of the protoplast (fig. 1, R). These coalesce into a single reserve globule which at first is often of somewhat irregular shape (Fig. 1, S), but later, in the fully mature zygospore, has a sharply defined circular contour (Fig. 1, T, a–f). In the mature zygospore the thin wall originally present is found reinforced by a conspicuously thicker inner layer, and the living protoplasm forms a layer of nearly homogeneous consistency between the wall and the reserve globule.

The ripe zygospore here thus has much the same internal organization as the homologous spores of *Conidiobolus utriculosus* and *C. brefeldianus*. However the curious though specious resemblance that the sexual apparatus of *C. brefeldianus* bears to sexual reproductive apparatus of monosporous oomycetes is not evident in the present fungus. Even in the occasional instances where conjugation takes place between hyphal segments originating in separate hyphae (Fig. 1, U, a, b) fertilization of an oogonium by an antheridium is never closely simulated. Owing to early fusion of all paired hyphal segments any globose enlargement with conformation and dimensions suggestive of an oogonium has very obviously received its contents in approximately equal measure from both segments.

A term (λαμπραυγης) meaning "lustrous" may serve conveniently as specific epithet of the fungus in bringing to mind the macroscopic appearance of its mycelium.

Conidiobolus lamprauges, sp. nov. Mycelium lente crescens (circa 2.5 mm in die), incoloratum, nitidum, aliquid ramosum, mox septatum, in hyphis 3–8μ (plerumque 4–7μ) latis constans; cellulis mycelii 35–200μ longis, saepius aliquid flexuosis, quandoque plus minusve disjunctis, interdum pluribus ramulis brevibus praeditis; hyphis conidiophoris simplicibus, erectis vel ascendentibus, in aere 25–100μ (vulgo 25–50μ) ad lucem protendentibus, interdum 5–15μ subter apicem parum inflatis, ibi 4–8μ latis, in apice unicum conidium ferentibus; conidiis se violenter abjicentibus, incoloratis, globosis, sed deorsum papilla rotundoconica vel hemisphaerica (1.5–4μ alta, 2.5–7μ lata) praeditis, 15–22μ (ex toto) longis, 12.5–20μ crassis, protoplasmatis dense granulosi repletis; zygosporis interdum e copulatione inter cellulam mycelii et tubum germinationis interdum e copulatione cellularum aliae atque aliae hyphae ortis, sed saepissime e copulatione cellularum duarum contiguarum ejusdem hyphae oriundis, hyalinis, globosis, plerumque 12–18μ crassis, in maturitate guttula nitida 7.5–11.5μ crassa et muro 1.3–2.2μ crasso praeditis.

Habitat in foliis quercorum putrescentibus in Arlington, Virginia.

Mycelium colorless, lustrous, at 20° C. growing radially about 2.5 mm in a day, moderately branched; assimilative hyphae somewhat flexuous, 3 to 8μ (mostly 4 to 7μ) wide, soon becoming divided by cross-walls at intervals of 35 to 200μ; the resulting hyphal segments sometimes remaining contiguous and at other times becoming disjointed, frequently after disjunction putting forth several short diverticulate or lobate branches. Conidiophores arising singly from individual hyphal segments, simple, colorless, projecting 25 to 100μ (commonly 25 to 50μ) erectly or ascendingly into the air, the aerial part always oriented toward the main source of light, often slightly widened and having a diameter of 4 to 8μ some little distance (mostly 5 to 15μ) below its tip whereon is borne a single conidium. Conidia filled with densely granular protoplasm, through sudden eversion of the upcurved basal membrane forcibly thrown off, colorless, globose, measuring 15 to 22μ in total length and 12.5 to 20μ in greatest width, the everted basal membrane forming a hemispherical or rounded-conical papilla 1.5 to 4μ high and 2.5 to 7μ wide at its origin. Conjugation sometimes taking place between a germ hypha and a hyphal segment, sometimes between 2 hyphal segments originating in separate mycelial filaments, but most often between 2 adjacent segments in the same mycelial filament; the fusion cell always initiated wholly within one of the gametangia, though in immediate proximity to the other gametangium; zygospore at maturity hyaline, globose, usually 12 to 18μ in diameter, containing an eccentrically placed reserve globule 7.5 to 11.5μ in diameter, provided with a wall commonly 1.3 to 2.2μ thick.

Occurring in decaying oak (*Quercus* spp.) leaves in woods in Arlington, Va.

A SPECIES WITH INCONSPICUOUS DISJUNCTIVE MYCELIUM AND PREDOMINANTLY DICLINOUS CONJUGATION

A species of *Conidiobolus* noticeably more robust than *C. lamprauges* was obtained from leaf mold kindly collected by A. W. Rakosy in Carroll County, N. H., late in September 1951. In maizemeal-agar plate cultures kept at temperatures near 20° C. it grows radially about 5 mm in 24 hours. Its submerged mycelium is inconspicuous, frequently being only indistinctly visible to the naked eye except at the sharply demarcated advancing margin, though it never vanishes from macroscopic sight as completely as the mycelium of two species of *Basidiobolus* that are widely distributed in leaf mold (Drechsler, 1952a). Viewed under the microscope an expanding mycelium of the fungus displays at its periphery terminal portions of many elongating hyphae mostly 6 to 8μ in width (Fig. 2, A). Very little tapering is observable below the bluntly rounded end. Formation of cross-walls ensues after about an hour, with the result that in many hyphae the most distal septum is found approximately 200μ from the tip. The segments delimited successively in the individual filaments vary moderately in length. Many are a little longer (fig. 2, J, a) or a little shorter (Fig. 2, J, b) than 100μ. As in *C. lamprauges* hyphal segments formed adjacent to one another may remain contiguous or may become disjointed through withdrawal of contents from one side of the separating cross-wall. After being delimited some segments will widen perceptibly, then occasionally attaining a diameter in excess of 10μ (Fig. 2, B, a). In addition such stout segments not infrequently will put forth branches only 3 or 4μ wide (Fig. 2, B, b, c) and will thereby in small compass display opposite extremes in thickness of filamentous parts.

Asexual reproduction takes place abundantly in maizemeal agar cultures of the fungus. An individual hyphal segment that is immersed under the substratum extends a branch or prolongation which on reaching the surface soon turns upward and after widening rather markedly (Fig. 2, C, a) forms a globose swelling at its tip (Fig. 2, C, b). A hyphal segment that has originated in a procumbent hypha often puts forth a branch erectly or ascendingly into the air(Fig. 2, D, a). This aerial branch, much like the aerial termination of a branch from a submerged segment, widens out markedly and then forms at its summit a globose swelling (Fig. 2, D, b) into which are soon received the entire protoplasmic contents of the reproductive unit. Thereupon the arched septum that was being formed progressively at the base of the globose part—its formation proceeding from the periphery inward—during the later stages in the upward movement of protoplasm, is completed through deposition of wall material in the keystone region. A subspherical conidium is thus delimited, and soon afterwards is thrown off violently on sudden eversion of the distal layer of the arched partition. Since the aerial conidiophores, as in related species, are in conspicuous degree positively phototropic, the direction of discharge is consistently toward the main source of light.

The conidia of the New Hampshire fungus (Fig. 2, E, a–j) are in general larger than those of *Conidiobolus lamprauges*. Often the basal membrane here (Fig. 2, E, a–c) would seem to protrude less abruptly from the globose outline of the spore than in *C. lamprauges*, but often, too, the everted wall protrudes hardly less markedly (Fig. 2, E, d–h) than in the latter species. Usually the conidia of *C. lamprauges* seem filled throughout with coarsely granular protoplasm, whereas those of the New Hampshire fungus show commonly a relatively clear peripheral layer that surrounds a large mass of conglutinated lumps. The lumps, varying in width from 1.5 to 3.5μ, have an irregularly globose shape and thus somewhat resemble small oil globules, but unlike oil globules are little given to coalescence. A conidium may germinate vegetatively by putting forth a germ hypha (Fig. 2, F) or it may extend a conidiophore of variable length and produce a secondary conidium (Fig. 2, G, H).

Sexual reproduction is accomplished by conjugation so simple that the general appearance given differs little from that of chlamydospore development. In some instances two adjoining segments of the same hypha (Fig. 2, I, a, b) serve as gametangia, the fusion cell arising as a globose swelling situated wholly within one segment but lying immediately adjacent to the other segment. The separating cross-wall disappears almost entirely at an early stage, so that the incipient enlargement soon receives protoplasmic materials from both directions. As a rule the "male" segment (Fig. 2, I, b) may be distinguished from the "female" (Fig. 2, I, a) by its narrower attachment to the young fusion cell. Conjugation between adjacent segments apparently occurs less frequently in the present species than scalariform conjugation between segments of different hyphae (Fig. 2, J, a, b). Since in diclinous reproductive apparatus, too, the fusion cell is initiated at the place of hyphal union and wholly within one of the two gametangia (Fig. 2, K) the zygote commonly develops in a position partly or wholly within the hyphal connection. At the place of union the apposed portions of outer membranes dissolve almost completely, so that here, just as in monoclinous apparatus, protoplasm flows into the young fusion cell from the "male" segment (Fig. 2, J, b) about as freely as from the "female" segment (Fig. 2, J, a). Indeed, the "male" segment (Fig. 2, J, b) will often have contributed all its contents when its mate (Fig. 2, J, a) still retains a considerable quantity of protoplasm. Soon after portions of conjugating hyphal segments have been evacuated the empty tubular membrane, together with the septa contained in it, collapses and disappears from view. Thus, only an hour after movement of protoplasm began in the unit of sexual apparatus shown in Fig. 2, J, less than a third of the original membranous envelope of the "male" segment (Fig. 2, K, b) and scarcely half of the original envelope of the "female" segment (Fig. 2, K, a) remained visible. Forty minutes later all membranous parts of the "male" gametangium had vanished, and only two short membranous spurs (Fig. 2, L, a), both left by the "female" gametangium, could be seen attached to the developing zygospore, which now had not only laid down its definitive delimiting walls but had begun internal reorganization by elabo-

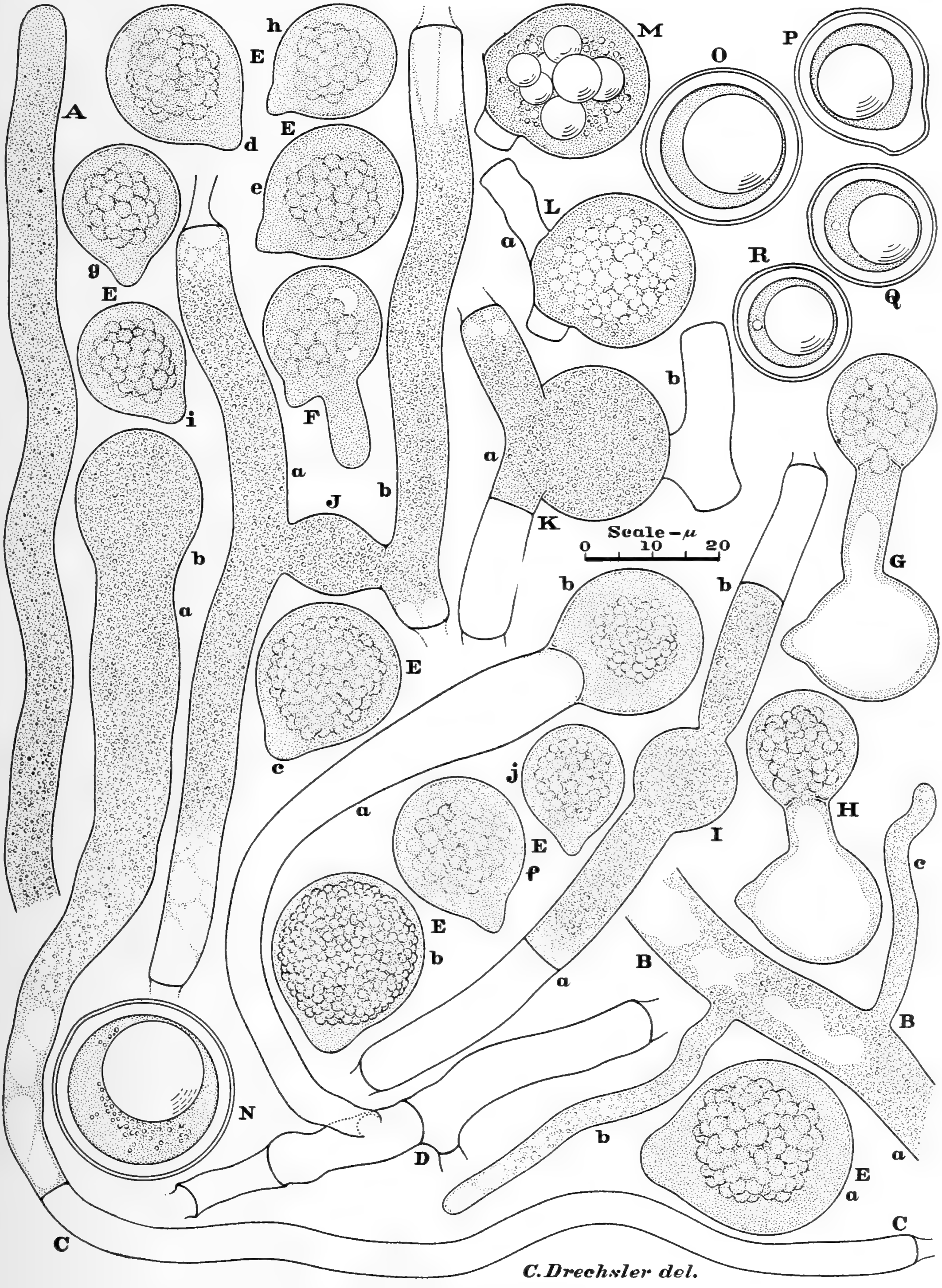

Fig. 2.—*Conidiobolus thromboides*, sp. nov., as found developing in pure culture on Petri plates of maizemeal agar; all parts drawn at a uniform magnification with the aid of a camera lucida; × 1000 throughout. Explanation of all parts given in text.

rating many oily globules in its central region. During the ensuing 30 minutes the longer of the two empty spurs vanished from sight, so that in little more than two hours after conjugation could be clearly ascertained the united hyphal segments were converted into a globose zygote (Fig. 2, M) with only a short empty cylindrical stub to indicate its origin from filamentous parts. The numerous small globules in the central region of the zygote had meanwhile coalesced to form seven or eight globules of considerably larger size.

Through continued coalescence of multiple globules a single large reserve globule is eventually formed. This body, much as in *Conidiobolus lamprauges*, lies well toward one side within the ripe zygospore (Fig. 2, N–R), a portion of its periphery approaching very close to the zygospore wall. Accordingly at maturity the protoplasm, which shows relatively few granules scattered in a limpid matrix of nearly homogeneous appearance, is disposed in a parietal layer pronouncedly thicker on one side than on the other. The thin envelope earlier surrounding the fusion cell is reinforced in the ripe zygospore by a much thicker inner layer presumably interpretable as the zygospore wall proper. Variability with respect to size is more moderate among zygospores of the New Hampshire fungus than might be inferred from the five individuals figured herein (Fig. 2, N–R), for one (Fig. 2, N) of the five—a specimen fully 27μ in diameter—was selected more especially to illustrate approximately maximum dimensions, while two others (Fig. 2, Q, R), each about 18μ in diameter, were selected to illustrate approximately minimum dimensions. Only two (Fig. 2, O, P) of the five individuals, with diameters of 23.5μ and 20μ, respectively, are of dimensions frequent in the species.

A term (θρομβοειδης) meaning "full of of clots or grains" may serve helpfully as specific epithet in recalling the conglutinated lumpy texture of conidial contents wherein the fungus differs markedly from the generally smaller *Conidiobolus lamprauges*.

Conidiobolus thromboides sp. nov. Mycelium circa 5 mm in die crescens, incoloratum, saepius parum conspicuum, aliquid ramosum, mox septatum, in hyphis 3–10.5μ (saepe 6–8μ) latis constans; cellulis assumentibus 50–200μ (saepe circa 100μ) longis, vulgo aliquid flexuosis, aliquando plus minusve disjunctis, interdum paucis angustis ramulis praeditis; hyphis conidiophoris simplicibus, erectis vel ascendentibus, in aere vulgo 35–150μ ad lucem protendentibus, sursum inflatis, ibi saepe 10–15μ latis, in apice unum conidium gignentibus; conidiis se violenter abjicentibus, incoloratis, globosis sed basi papilla rotundoconica vel hemisphaerica (2.5–6μ alta, 4–10μ lata) praeditis, plerumque ex toto 24–32μ longis, 19–26.5μ latis, in magna parte praecipue in medio glebarum protoplasmatis conglutinatarum repletis; zygosporis interdum e copulatione cellularum aliae atque aliae hyphae interdum e copulatione cellularum duarum contiguarum ejusdem hyphae oriundis, hyalinis, globosis, 17.5–27μ (plerumque 19.5–23.5μ) crassis, in maturitate guttula nitida 10–15μ crassa et muro magnam partem 2–2.5μ crasso praeditis.

Habitat in humo silvatica in New Hampshire.

Mycelium colorless, often rather inconspicuous, moderately branched, at temperatures near 20° C. growing radially about 5 mm in a day; assimilative hyphae somewhat flexuous, 3 to 10.5μ (mostly 6 to 8μ) wide, soon becoming divided by cross-walls at intervals of 50 to 200μ; the hyphal segments sometimes remaining contiguous but at other times becoming disjointed, and in some instances putting forth one or more narrow branches. Conidiophores arising singly from individual hyphal segments, simple, colorless, projecting 35 to 150μ (often about 100μ) erectly or ascendingly into the air, the aerial part oriented toward the main source of light, distally inflated, often measuring 10 to 15μ in greatest width, bearing a single terminal condiium. Conidia forcibly thrown off through sudden eversion of the arched basal membrane, colorless, usually in large part filled with somewhat conglutinated protoplasmic lumps, globose, often measuring 24 to 32μ in total length and 19 to 26.5μ in greatest width, the everted basal membrane forming a hemispherical or rounded-conical papilla 2.5 to 6μ high and 4 to 10μ wide at its origin. Conjugation most usually taking place between two hyphal segments originating in separate mycelial filaments but sometimes taking place between two adjacent segments in the same filament; the fusion cell always initiated wholly within one segment and in immediate proximity to the other; zygospore at maturity hyaline, globose, 17.5 to 27μ (mostly 19.5 to 23.5μ) in diameter, containing a very eccentrically placed reserve globule 10 to 15μ in diameter, and provided with a wall for the most part 2 to 2.5μ thick.

Occurring in leaf mold in Carroll County, N. H.

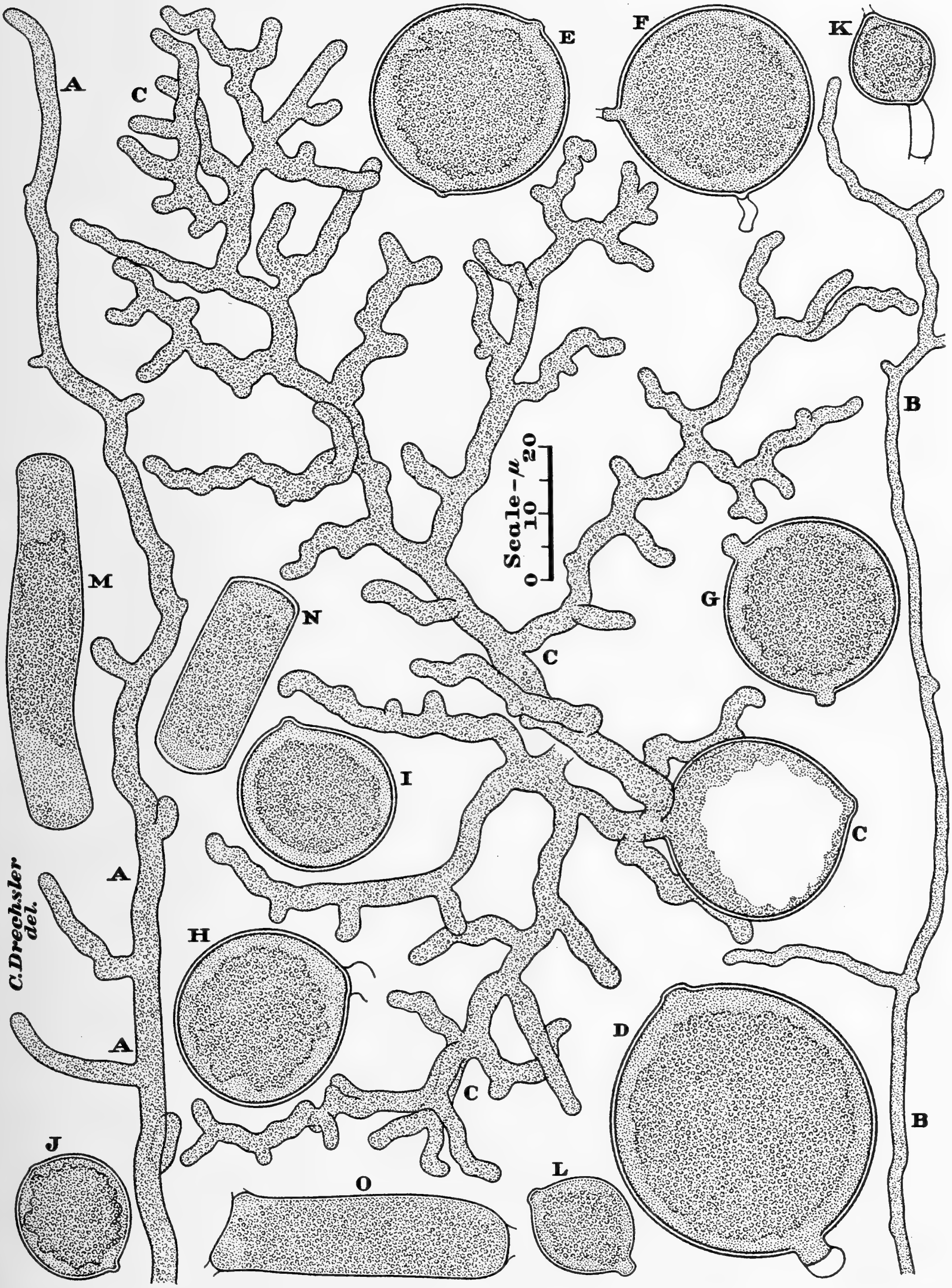

FIG. 3.—*Conidiobolus adiaeretus*, sp. nov., as found developing in pure culture on Petri plates of maizemeal agar; all parts drawn at a uniform magnification with the aid of a camera lucida; × 1000 throughout. Explanation of all parts given in text.

A SPECIES WITH ROBUST CONIDIOPHORES ARISING FROM RICHLY BRANCHED DELICATE MYCELIUM

An entomophthoraceous fungus especially distinctive in its vegetative stage was first found developing in agar plate cultures prepared with leaf mold collected near Farmer, N. C., in December 1951. Subsequently it was obtained also from leaf mold gathered in eastern central New Hampshire late in September 1951; from leaf mold gathered in oak woods along Lubbers Run in Arlington, Va., on February 28, 1952; from leaf mold collected near Criglersville, Va., on March 23, 1952; and from various kinds of plant detritus taken up in several places near Beltsville, Md., at different times during January and February 1952. On maizemeal agar of moderate firmness it grows slowly, producing a lustrous mycelium somewhat more nearly opaque and correspondingly more conspicuous than the mycelium of *Conidiobolus lamprauges*. Before an individual mycelium has spread extensively it produces conidiophores from which conidia are thrown for distances of several millimeters toward the main source of light. Falling on a moist substratum many of these conidia give rise collectively to scattered subsidiary mycelia which soon occupy the area completely thereby barring further growth in that region by the parent mycelium. As the same sequence of events is repeated another array of mycelia come into being a little farther onward, which in their turn form a barrier against those to their rear. The fungus thus spreads over an expanse of substratum by establishing numerous demarcated mycelia that in large part remain discernible as individuals and therefore in the end often appear collectively as a patchwork of lustrous areas. Ordinarily no similar patchy or dappled effect is noticeable in related fungi, for while these likewise habitually colonize adjacent areas, their outlying mycelia—often from the first too transparent to stand out individually in clear relief—become merged indistinguishably when they coalesce.

Under a microscope an extensive unobstructed mycelium of the present fungus shows along its growing margin numerous hyphae that measure mostly 3.5 to 4μ in width, though in the distal portion they taper gradually to an apical width of approximately 3μ (Fig. 3, A). Here and there in older cultures narrower hyphae are found which over considerable stretches may not exceed 2μ in width and, indeed, may in some portions measure as little as 1.8μ in this dimension (Fig. 3, B). The greatest width sustained for some distance in the stouter filaments would seem approximately 4.5μ (Fig. 4, A). Only rather moderate development of lateral branches occurs at the margin of an extensive mycelium (Fig. 3, A). Abundant branching is, however, usual in the earlier development of a mycelium from a germinating conidium. The ramified procumbent outgrowths shown in Fig, 3, C, represent only about one-twentieth of the entire three-dimensional hyphal system formed within a radius of 150μ from an individual spore.

In older portions of an extensive mycelium many of the lateral branches (Fig. 4, A, r; B, r) are empty of protoplasmic contents and accordingly are found delimited basally from the parent hypha by a retaining wall. A much smaller number continue growth distally to give rise to conidiophores (Fig. 4, A, a; B, a; C, a). As the conidiophores here are often 20μ or more in greatest width they offer a pronounced dimensional contrast with the mycelial filaments. The prolonged transfer of granular materials into the growing terminal conidium (Fig. 4, B, b) is not regularly accompanied, as in related species, by evacuation of a particular hyphal segment, or of any adjoining portion of axial hypha. When eventually the conidiophore is delimited by a basal septum (Fig. 4, C, a) the axial hypha and the connecting branch are often still filled with granular protoplasm. An arched septum is progressively laid down at the base of the conidium (Fig. 4, C, b) during the later stages in the upward movement of living contents. Soon after the septum has been completed, it is suddenly split into two layers. The distal layer at the same time is briskly everted, with the result that the conidium is thrown off forcibly. The distances spores are propelled here seem appreciably less than in *Delacroixia coronata* and *Conidiobolus brefeldianus*. Feebler propulsion might readily be expected since in my fungus the basal septum is arched less prominently, and therefore in being everted delivers a shorter and presumably less powerful stroke.

The largest of the primary conidia (Fig. 4, D) produced by the fungus measure approximately 46μ in total length and 45μ in width. Well developed primary conidia commonly vary between 30 and 40μ in both dimensions (Fig. 4, E, F). Individuals less than 25μ (Fig. 4, G–M) would mostly seem to represent products of repetitional development. Such development

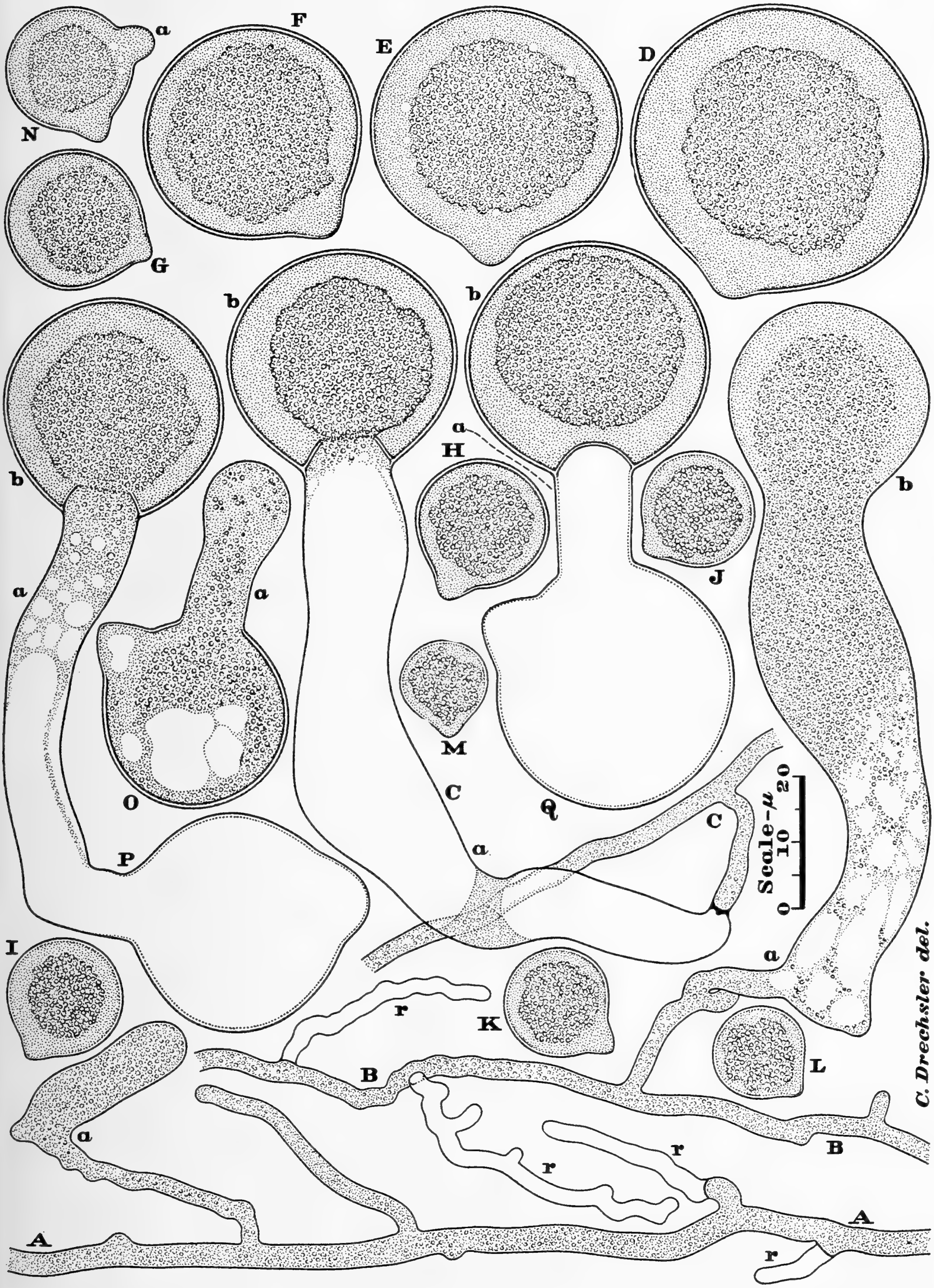

Fig. 4.—*Conidiobolus adiaeretus*, sp. nov., as found developing in pure culture on Petri plates of maizemeal agar; all parts drawn at a uniform magnification with the aid of a camera lucida; × 1000 throughout. Explanation of all parts given in text.

takes place very freely in the present species. A protuberance is bourgeoned forth (Fig. 4, N, a) which after some elongation (Fig. 4, O–Q: a) swells distally to form a globose secondary conidium (Fig. 4, P, b; Q, b) that is thrown off forcibly in the same way as was its parent. As the reduction in size incurred in one repetitional generation is not especially pronounced in instances where the conidiophorous outgrowth is of moderate length, many secondary conidia (Fig. 4, P, b; Q, b) measure 30 to 40μ in diameter and thus after discharge are not distinguishable from well developed primary conidia. With respect to their internal organization the conidia, both large and small somewhat resemble those of *Conidiobolus thromboides* in having a rather dense conglutinated central mass of protoplasm surrounded by a hyaline parietal layer. However the central mass here is less coarse in texture, its constituent particles being granules rather than lumps. When conidia are mounted in moist agar under a cover glass and subjected to microscopical examination in strong light the conglutinated mass soon contracts noticeably and the clear parietal layer becomes interspersed with vacuoles of increasing number and size.

At temperatures near 20° C. aerial conidia are the only reproductive bodies formed by the fungus. On being stored at temperatures near 7° C. tubes of maizemeal agar well permeated with mycelium will permit copious formation of chlamydospores mainly under the surface of the culture medium. Since these chlamydospores, usually of globose or prolate ellipsoidal shape, very often show two truncated protuberances in opposite positions (Fig. 3, D–G), they appear largely of intercalary origin. Specimens showing only one protuberance suggestive of hyphal attachment (Fig. 3, H, I) seem of terminal origin. Most chlamydospores, like most conidia, vary in diameter from 25 to 40μ (Fig. 3, D–H). Small individuals (Fig. 3, I–L), corresponding in their dimensions to conidia derived through successive repetitional development, are usually found only in meager quantity. Somewhat indurated cylindrical cells (Fig. 3, M–O), often about three times as wide as unmodified assimilative hyphae, are perhaps to be regarded as imperfectly differentiated chlamydospores. They often show conglutinated granules in the middle region and clear protoplasm at both ends (Fig. 3, M, N). In well differentiated globose chlamydospores, much as in conidia, a relatively large conglutinated granular mass is surrounded by a parietal layer of more nearly transparent protoplasm.

The fungus is referred to *Conidiobolus* since it grows well on ordinary culture media and in its asexual reproduction does not differ very widely from *C. utriculosus*, the type species of that genus. Its mycelium differs conspicuously from that of *C. utriculosus*, *C. brefeldianus*, *C. lamprauges*, and *C. thromboides* not only in the slenderness of the component hyphae but also in their frequently copious branching. Although the fungus forms numerous septa that serve as retaining walls in closing off evacuated lateral branches from the living axial hyphae, early deposition of cross-walls to separate adjacent living segments—a very usual feature in the vegetative growth of other readily cultivable Entomophthoraceae—is not characteristic of its mycelial development. In agar plate cultures it shows no disjunction of living hyphal segments. A term (*αδιαιρετος*) meaning "undivided" is therefore deemed a suitable specific epithet.

Conidiobolus adiaeretus, sp. nov. Mycelium lente (circa 2 mm in die) crescens, nitidum, conspicuum; hyphis assumentibus, incoloratis, vulgo 1.8–4.5μ latis; interdum mediocriter interdum copiose ramosis, ramulis brevibus saepe mox inanitis denique ab hyphis viventibus longis septo finitis; hyphis conidiophoris incoloratis, simplicibus, erectis vel ascendentibus, in aere vulgo 50–100μ (rarius 100–250μ) ad lucem protendentibus, rectis vel curvatis, vulgo speciose inflatis, 8–25μ (saepius 15–23μ) latis, in apice unum conidium gignentibus; conidiis se violenter adjicentibus, incoloratis, globosis vel applanato-ellipsoideis sed basi papilla rotunda (2–6μ alta, 5–17μ lata) praeditis, plerumque ex toto 15–46μ longis, 13–45μ latis, in parte parietem juxta protoplasmatis hyalini repletis in parte media granulis conglutinosis farctis; chlamydosporis plerumque intra materiam permeatam oriundis, incoloratis, plerumque intercalaribus, interdum terminalibus, vulgo globosis vel elongato-ellipsoideis, 15–45μ longis, 3–40μ latis, in parte parietem juxta protoplasmate hyalino in parte media granulis conglutinosis instructis.

Habitat in foliis arborum (praecipue quercorum) putrescentibus prope Farmer, N. C., et prope Beltsville, Md., et prope Criglersville, Va., et in Arlington, Va., et in New Hampshire, etiam in aliis materiis plantarum putrescentibus prope Beltsville, Maryland.

Mycelium growing slowly (about 2 mm in 24 hours at 20° C.), lustrous, conspicuous; assimilative hyphae colorless, mostly 1.8 to 4.5μ wide, sometimes moderately and sometimes abundantly branched, the shorter branches often emptied early of their protoplasm and then delimited basally by a retaining wall; conidiophores colorless, simple, straight or curved, projecting 50 to 200μ (or more) erectly or ascendingly into the air, the aerial part oriented toward the main source of light, often pronouncedly inflated, 8 to 25μ (commonly 15 to 23μ) in greatest width, bearing a single conidium at the tip; conidia forcibly thrown off through sudden eversion of the arched basal membrane, colorless, containing a parietal layer of hyaline protoplasm which surrounds a large irregular mass of conglutinated granules, subspherical or sometimes oblate ellipsoidal in general shape, measuring 15 to 46μ in total length and 13 to 45μ in width, their everted basal membrane forming a rounded papilla 2 to 6μ high and 5 to 17μ wide; chlamydospores formed mainly within the substratum, borne intercalarily or terminally, mostly globose or ellipsoidal, 15 to 45μ long and 13 to 40μ wide, colorless, containing a large central mass of conglutinated granules that is surrounded by a parietal layer of hyaline protoplasm.

Occurring in decaying leaves of trees (especially of *Quercus* spp.) in woods near Farmer, N. C.; near Beltsville, Md.; near Criglersville, Va.; in Arlington, Va.; in Carroll County, N. H.; and also in other decaying plant materials near Beltsville, Md.

REFERENCES

Brefeld, O. Conidiobolus utriculosus *und* minor. Unters. Gesammtg. Mykologie **6:** 35–72, 75–78, pl. 3–5. 1884.

Couch, J. N. *A new* Conidiobolus *with sexual reproduction.* Amer. Journ. Bot. **26:** 119–130. 1939.

Drechsler, C. *Widespread distribution of* Delacroixia coronata *and other saprophytic Entomophthoraceae in plant detritus.* Science **115:** 575–576. 1952.

———. *Two species of* Basidiobolus *widely distributed in leaf mold.* (Abstract) Phytopathology **42:** 341. 1952a.

Gilbert, E. M. *A peculiar entomophthorous fungus.* Trans. Amer. Micr. Soc. **38:** 263–269, pl. 27, 28. 1919.

White, W. L. *Note on* Conidiobolus. Mycologia **29:** 148–149. 1937.

BOTANY.—*The species of* Pittosporum *in Formosa.* Hui-Lin Li, Morris Arboretum, University of Pennsylvania.

There are five species of the genus *Pittosporum* on the island of Formosa. Two of them are more or less widespread in Formosa and extend also widely on the mainland of China. One is confined to the southern part of the island, and another is found only on the small island of Botel Tobago. These two southern species described as endemic to Formos are actually found to be only the northernmost populations of two widely distributed Philippine species. A fifth species is endemic to Formosa at high altitudes only.

Recently a treatise on the *Pittosporum* species of eastern Asia was published by M. Gowda (*The genus* Pittosporum *in the Sino-Indian Region.* Journ. Arnold Arb. **32:** 263–343. 1951). Six species[1] from Formosa are accounted for, his findings being very much at variance with those of the present writer. Gowda considers the Formosan plant known as *P. makinoi* to be distinct, but in the present study it is treated as conspecific with the widely distributed *P. tobira.* For *P. illicioides* treated as a single species here, two separate species under different names are recognized by Gowda, one described as new. Gowda did not recognize the identity and relationship with Philippines species of the two southern species of Formosa. As *Pittosporum* is primarily a southern genus, the nature of some of the southernmost species in Formosa, on the Chinese mainland, and in India cannot be properly elucidated without consulting related species of the southern islands of Asia.

Selected specimens are cited from the U. S. National Herbarium, Smithsonian Institution, indicated as (US), and the herbarium of the National Taiwan University, Formosa, indicated as (NTU).

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[1] On page 282, Gowda mentions that there are five species known from Formosa. He inadvertently left out his own new species, *P. sahnianum*, which he credited to Formosa on the basis of *Wilson 11066*.

KEY TO THE FORMOSAN SPECIES

A. Flowers, few, fasiculate, from axils of upper leaves, with slender peduncles; fruit often solitary......................1. *P. illicioides*
AA. Flowers or fruits usually many, in terminal racemes or spikes.
  B. Leaves broadest at or below middle, apex acute; fruit small, less than 1 cm across.
    C. Leaves large, 10–15 cm long; fruit very small, about 6 mm across
2. *P. daphniphylloides*
    CC. Leaves smaller, about 6–9 cm long; fruit larger, about 8 mm across
3. *P. pentandrum*
  BB. Leaves usually broadest above middle, apex obtuse to rounded; fruit large, 1.5 cm or more across.
    C. Leaves 6–8 cm long and 2–3 cm broad; fruit about 1.5 cm across.........4. *P. tobira*
    CC. Leaves larger, 8–12 cm long, 3–5 cm broad; fruit about 2 cm across
5. *P. littorale*

1. **Pittosporum illicioides** Makino in Bot. Mag. Tokyo **14:** (31). 1900; Migo in Journ. Jap. Bot. **16:** 566. 1940.

Pittosporum oligocarpum Hay. in Journ. Coll. Sci. Univ. Tokyo **30** (1): 35. 1911 (Mat. Fl. Formos.); Icon. Pl. Formos. **1:** 63. 1911; Kanehira, Formos. Trees **45:** 1917, rev. ed. 249. *f. 193*, 1936; Gowda in Journ. Arnold Arb. **32:** 304. 1951.

Pittosporum oligospermum Hay. Icon. Pl. Formos. **3:** 31. 1913, *ibid.* **5:** 7. *f. 2.* 1915.

Pittosporum sahnianum Gowda in Journ. Arnold Arb. **32:** 305. 1951. *Syn. nov.*

Widely distributed and common on the Chinese mainland and in Formosa, at medium to high altitudes.

Formosa: Arisan, *E. H. Wilson 9774* (US); Seisui, prov. Karenko, *E. H. Wilson 11066* (US); Sikayotaizan, *G. Masamune 1296* (NTU).

Gowda overlooked Migo's paper which also considers *P. glabratum* Lindl. as confined to southern China, while the plant of central China, generally referred to *P. glabratum*, is the same as *P. oligocarpum* Hay. of Formosa and *P. illicioides* Makino of Japan. Gowda maintains the last two as two distinct species, although for *P. illicioides* he had access to only a sterile twig.

For this widespread and common plant, Gowda recognizes two species as occurring on both the Chinese mainland and in Formosa: *P. oligocarpum* Hay. and *P. sahnianum* Gowda. The first is found mainly in Formosa but is also recorded from Chekiang and Kiangsi. The second is widespread on the Chinese mainland but is also credited to Formosa on the basis of *Wilson 11066*. In his key the two species are differentiated mainly by the size of the fruit as follows:

"Capsules extremely small, 6 mm long, without abruptly constricted stipe; inflorescence a simple cyme; flowers small, petals usually 6–7 mm long; pedicels extremely slender, less than 1 mm thick......................*P. oligocarpum*
Capsules large, 10 mm long; stipe abruptly constricted; inflorescence a cluster of single flowers; flowers large, petals usually 8 mm long; pedicels more than 1 mm thick..........*P. sahnianum*"

If one studies the actual specimens, it is clear that these differences are exaggerated. Gowda's own descriptions do not agree with his key. He gives no measurement for the capsule of *P. sahnianum* in the description of the species, but for *P. oligocarpum*, the size of the capsule is given as 7–9 mm instead of 6 mm long and it is "without or with inconspicuous stipe" instead of without stipe as mentioned in his key. Among the numbers he cited for *P. sahnianum* that are available to me, such as *Chiao 14798*, *Wilson 1674*, *Ching 1455*, *2264*, etc., there appears considerable variation in the size of the capsule, in part apparently due to age, but evidently also due to its inherent variable nature. These capsules vary from 6 to 12 mm in length. The stipe at the base is generally conspicuous but varies considerably in length and diameter. The pedicles are often very slender, comparable to those of *P. oligocarpum* from Formosa. Specimens of *P. oligocarpum* cited by Gowda from Chekiang, *Ching 1874*, and from Formosa, *Wilson 9774*, have capsules varying from 6–9 mm long and also with a distinct but short stipe. It is true that the Formosan plants have generally smaller capsules, but the size of capsule alone does not indicate species differentiation in such a variable and widely distributed species. *Wilson 11066* from Formosa, cited by Gowda as representing *P. sahnianum*, has capsules measuring about 10 mm long. But compared with *Wilson 9774*, also from Formosa but cited by him as *P. oligocarpum*, besides the very slight difference in the size of the fruits, there is not the slightest difference in other characters that can separate the two specimens specifically. Clearly only one species is represented in Formosa, and this is evidently also conspecific with the plants on the mainland of China known as *P. glabratum* auct. non Lindley and in Japan known as *P. illicioides* Makino. It seems that on the whole too many species are recognized by Gowda in his treatment of the genus in eastern Asia, with over-emphasis on some minor variations probably of no genetic significance.

2. **Pittosporum daphniphylloides** Hay. in Journ. Coll. Sci. Tokyo **30** (1): 34. 1911; Icon. Pl. Formos. **1:** 65. 1911; *ibid.* **5:** 6. 1916; Kanehira, Formos. Trees, rev. ed. 248. *f. 191.* 1936; Gowda in Journ. Arnold Arb. **32:** 336. 1951.

Formosa, at high altitudes, central and eastern part of the island; usually epiphytic.

Formosa: Arisan, *E. H. Wilson 10803* (US); Taito, *Mori 11548* (photo of isotype, US).

3. **Pittosporum pentandrum** (Blanco) Merr. in Govern. Lab. Publ. (Philip.) **27:** 19. 1905.
   Aquilaria pentandrum Blanco, Fl. Philip. 373. 1837.
   Pittosporum formosanum Hay. in Hay. & Matsum. in Journ. Coll. Sci. Tokyo *22:* 32. *f. 4.* 1906 (Enum. Pl. Formos.); Kanehira, Formos. Trees, rev. ed. **249.** *f. 192.* 1936; Gowda in Journ. Arnold Arb. **32:** 327. 1951. *Syn. nov.*
   Pittosporum undulatum sensu Hay. in *op. cit.* 33, non Vent.

Southern Formosa, Hunchuen Peninsula, and Botel Tobago, along the seashore; also in Indo-China.

Formosa: Takao, *A. Henry 1058* (US), *E. H. Wilson 9853* (US); Bankinsing, *A. Henry 48* (US); Kuraru, Prov. Koshun, *E. H. Wilson 11001* (US).

This species occurs commonly in the southernmost part of Formosa and on the island of Botel Tobago, along the seashore. The Formosan specimens are doubtless conspecific with *P. pentandrum*, a very common and widely distributed species of the Philippine islands. Gowda records *P. formosana* as also occurring in Tonkin, Indo-China. A variety of this species with pubescent ovary occurs in Tonkin and Hainan: *P. pentandrum* (Blanco) Merr. var. *hainanense* (Gagnepain) comb. nov. (*P. formosanum* var. *hainanense* Gagnepain, Fl. Gén. Indo-Chine **1:** 238. 1909, Suppl. **1:** 214. 1939).

4. **Pittosporum tobira** Ait. Hort. Kew, ed. 2, **2:** 27. 1811; Kanehira, Formos. Trees, rev. ed. 250. *f. 192.* 1936.
   Pittosporum makinoi Nakai, Fl. Sylv. Korea. **21:** 84. 1936; Gowda in Journ. Arnold Arb. **32:** 311. 1951. *Syn. nov.*
   Pittosporum tobira var. *calvescens* Ohwi in Journ. Jap. Bot. **12:** 311. 1936.

Widely distributed in eastern Asia; very common along the coastal region in the northern part of Formosa.

Formosa: Keelung, *T. Tanaka & Y. Shimada 11023* (US); Toyen, Sinchikushu, *T. Tanaka & Y. Shimada 13539* (US); Sozan, Taihoku, *E. H. Wilson 10790* (US); Silin, Taipeh, *H. Keng 1034* (US); Sin-chow, prov. Karenko, *E. H. Wilson 11094* (US); Shusin to So-o, Prov. Taihoku, *E. H. Wilson 10285* (US).

The Formosan plant is variously considered as conspecific with the widely distributed *P. tobira*, as by Kanehira, as a variety of the latter species, as by Ohwi, and as a distinct species, as by Nakai. Gowda follows Nakai in calling the Formosan plant a distinct species. Ohwi considers his variety as different from the typical form of *P. tobira* in the less pubescent habit and the slightly pilose ovary. Gowda says that the Formosan plant *P. makinoi* very closely resembles *P. tobira*, differing in having a glabrous inflorescence. The inflorescence is described by him as "usually glabrous," but in his key it is given as "inconspicuously pilose." In the original description of Nakai, the inflorescence is described as minutely and sparsely pilose. Actually the inflorescence is in general pubescent, as in *P. tobira* from other regions, such as Japan, Korea, and China. Gowda also tries to differentiate the two on the basis of their leaf shape, but his characterizations: "leaves obovate, broadest above middle and abruptly rounded at apex, frequently emarginate" for *P. tobira* and "leaves usually obovate, broadest above the middle, usually rounded at apex" for *P. makinoi*, show that leaf shape cannot be successfully utilized. Clearly this Formosan plant, common especially along the coastal regions in the northern parts, is conspecific with the widespread species *P. tobira*, of China, Japan and Korea, also mainly of the coastal regions.

Gowda is also inconsistent in his emphasis on the pubescence of the inflorescence, as he describes two varieties with glabrous inflorescence, var. *fukienense* from Fukien and var. *sukuraii* from the Bonin islands, under the species *P. tobira*, which is considered by him as different from *P. makinoi* and others in having the character of the inflorescence "very conspicuously tomentose".

5. **Pittosporum littorale** Merr. in Philip. Journ. Sci. **5.** Bot.: 179. 1910.

Pittosporum viburnifolium Hay. Icon. Pl. Formos. **3:** 32. 1913; Kanehira, Formos. Trees, rev. ed. 251. *f. 195.* 1936; Gowda in Journ. Arnold Arb. **32:** 323. 1951. *Syn. nov.*

Formosa, in Botel Tobago Island only, and the Philippines.

This species is known in Formosa only from Botel Tobago Island and is the same as *P. littorale* of the Philippines; several specimens of the latter, including *Merritt 9845*, isosyntypes, are available for comparison. The oblanceolate and obtuse leaves, large flowers, and the subglobose 2-valved capsules are distinctive characteristics of the species. The plants grow in thickets along the seashore.

ENTOMOLOGY.—*The Diptera collected on the Cockerell and Hubbell Expeditions to Honduras: Part II, Asilidae.*[1] MAURICE T. JAMES, State College of Washington.

The present paper, based on material collected in Honduras by Prof. and Mrs. T. D. A. Cockerell during the winter of 1946–47 and by Dr. T. H. Hubbell in 1923 and again in 1948, lists 37 species of Asilidae from Honduras, of which 8 are new and 2 are at least in part redescribed. I am indebted to Dr. A. Earl Pritchard who, though he could not critically review the manuscript, read it and gave me several valuable suggestions.

Psilonyx (*?macropygialis* (Williston)), 1901. Biologia Centrali-Americana, Diptera, **1:** 301 (*Leptogaster*). Reference is made with doubt to this species because the specimen before me lacks the apical half on the abdomen. Aguan River Valley, Copete farm, April 10, 1923 (T. H. Hubbell), no. 355, 1 male.

Leptogaster spp. Three specimens, representing three species, from Zamorano, can not safely be referred to known species nor described as new, because of the condition of the literature in this group.

Asilus tuxpanganus Bellardi, 1862. Saggio di ditterologia Messicana, Appendice: 22. Escuela Agrícola Panamericana, Zamorano, July 24, 1948 (T. H. Hubbell), plain, Yeguare River, no. 141, 1 male, 1 female; same, July 1, 1948, roadside, no. 10, 1 male; same, creek bank, July 19, 1948, no. 103, 1 male.

Asilus tenebrosus Williston, 1901. Biologia Centrali-Americana, Diptera, **1:** 328. Cerro Uyuca, Dept. Morazán, July 24, 1948 (T. H. Hubbell), 5,900–6,100 feet, cloud forest, no. 139, 1 male.

Ommatius near *marginellus* (Fabricius), 1781. Species insectorum **2:** 464 (*Asilus*). Dos Aguas, 8 km west, October 27, 1946 (Cisneros), 1 male; Río Claura, April 12, 1923 (T. H. Hubbell), no. 245, 1 male.

Ommatius parvus Bigot, 1875. Ann. Soc. Ent. France (5) **5:** 247. Escuela Agrícola Panamericana, Zamorano: July 1, 1948 (T. H. Hubbell), 2,600 feet, roadside, no. 10, 5 males, 7 females; August 2, 1948 (Hubbell), 2,700 feet, oak woods, no. 180, 2 males; July 22, 1948 (Hubbell), 2,650 feet, herbage and brush, no. 125, 1 male, 2 females; July 8, 1948 (Hubbell), 2,550 feet, plain, Yeguare River, no. 39, 2 males, 2 females; July 2, 1948 (Hubbell), plain, Yeguare River, 2,550 feet, no. 18, 1 female; July 19, 1948 (Hubbell), 2,600 feet, creek bank, no. 103, 1 female; July 29, 1948 (Hubbell), 2,650 feet, thicket, 1 female; July 10, 1948 (Hubbell) 2,700 feet, llanos, no. 50, 1 male. Los Llanos, Dept. El Paraíso, E. slope Zamorano Valley, Guinope Road, July 9, 1948 (Hubbell), 3,000 feet, no. 44, 1 male, 2 females.

Eicherax flavescens, n. sp.

A small species with predominantly silvery pile and silvery to yellowish pollen, predominantly yellow legs, and the body ground color tending to yellow; one pair of scutellar bristles.

Male.—Head black, densely covered with pollen, which is yellowish on the front and vertex and otherwise silvery. Facial prominence covering lower two-thirds of face, not especially strong; mystax dense, white except two small bristles above; a few black and white bristles and hairs along the ocular orbits, to the side of and above the antennae; ocellar bristles small, ocellar triangle small and otherwise devoid of vestiture; beard and postocular fringe white; six bristles on each side of upper part of occiput, mostly black. Antennae black with short black setulae; ratio of first, second, and third segments and arista 8: 4: 10: 15. Palpi black, black-haired.

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[1] For part I of this series, see Pan-Pac. Ent. **26** (2): 86–90.

Proboscis shining black, in some reflections bluish black, with long white hairs below.

Thorax black, the ground color becoming yellowish to reddish on the humeri, postalar wall and parts of the postalar callus, metanotal slopes, and posterior half of pleura approximately behind a line drawn along the posterior margin of the mesopleura; scutellum and metanotum black. Pollen of mesonotum, uppermost parts of mesopleura, and scutellum yellowish; a geminate mid-dorsal vitta and an adjacent oval area on each side, interrupted by the suture, more brownish pollinose, in places subshining; bristles and hairs of mesonotum, except a scattered few before the suture, and hairs of uppermost parts of mesopleura black; those of scutellum and otherwise of pleura white; scutellum with a pair of bristles and with short scattered hairs. Legs predominantly yellow; coxae in part black; each femur with a broad black dorsal vitta; tibiae, especially hind pair, blackened at apex; tarsi with fifth tarsomeres and narrow apices of the others brownish. Leg bristles apparently of variable color, but apparently wholly white on coxae, wholly white or almost so on femora, mixed black and white on tibiae, and predominantly black on the tarsi. Venation normal for the genus, that is, of the *Asilus* type; wing subhyaline, clouded at the apex (roughly beyond base of second submarginal); veins yellow; halteres yellow.

Abdomen chiefly reddish yellow in ground color, the second, sides of the first, and base of the third terga, and the apical half of the eighth sternite blackish; some short black inconspicuous hairs medially on the terga and dorsally on the hypopygium, vestiture otherwise white; pollen yellowish dorsally, white to silvery ventrally; two to three white bristles on each posterior angle of the terga, but these becoming small and inconspicuous beyond tergum 3; first three sterna each with several long bristle-like setulae; segments seven and eight very short. Genitalia (Fig. 1) large, eighth sternite strongly produced posteriorly, at base with a crest of appressed white hairs and with the hairs to the side of and behind this crest directed backward to form a broad, rather loose, silky tuft.

Length, 10 mm.

Female.—Mystax not as dense as in the male; hairs all white but the bristles on its upper part and one to two on each side of the oral margin black. Abdomen predominantly black, reddish only in spots on the sides of the segments and toward their apices. Eighth and ninth segments shining black, eighth longer than the preceding segments, relative lengths of segments 6 to 9 inclusively 25: 25: 35: 20; eighth segment broad at its base but soon becoming laterally compressed, the ninth compressed. Otherwise except sexually as described for the male.

Types.—Holotype male, Olanchito, Honduras, April 24, 1923 (T. H. Hubbell), no. 382; University of Michigan Museum of Zoology. Allotype female, Escuela Agrícola Panamericana, Zamorano, Morazán, July 1, 1948 (T. H. Hubbell), 2,600 feet (garden), no. 13.

Remarks.—This is the second species of this small neotropical genus to be recorded from Central America. *E. nigripes* (Bellardi) was described from Mexico and subsequently recorded from Guatemala by Hine (1917). Carrera (1950) recognizes *Eicherax* as a valid genus; Curran (1934) and Bromley (1934) obviously included it in *Erax*, though later Bromley (1946) apparently admitted its distinctness and listed four species from Brazil, including the widespread *E. nigripes* and *E. macularis* (Wiedemann), the genotype *E. simplex* (Macquart), and *E. ricnotes* (Engel), 1929. The black legs will readily distinguish all but *simplex* from the present species, and *simplex* is described as having only the hind femora blackened above, the description, based on a female, otherwise fitting *flavescens* well, except that no mention is made of the reddish-yellow ground color of the pleura. Since Macquart's type came from Rio Negro, Brazil, it is quite unlikely, in view of these discrepancies, that he had the same species.

Erax barbatus (Fabricius), 1805. Systema antliatorum: 169 (*Dasypogon*). Tela, Dakota farm, May 23, 1923 (Hubbell), no. 608, 5 males, 1 female; Tela, March 14, 1923 (Hubbell), no. 67, 1 male; Tela, March 10, 1923 (Hubbell), no. 47, 3 females; Tela, La Fragua farm, May 7, 1923 (Hubbell), no. 128, 1 male; Tela, Lancetilla, July 28, 1948 (Hubbell); Puerto Castilla, March 3, 1923 (Hubbell), no. 2, 1 male, 1 female, April 26, 1923 (Hubbell), no. 392, 1 male; Escuela Agrícola Panamericana, Zamorano, Morazán, July 1, 1948 (Hubbell), no. 10, roadside, 2,600 feet, 1 male; same, July 8, 1948, no. 39, plain, Yeguare River, 2,550 feet, 1 male, 1 female; same, December 6, 1946 (W. P. Cockerell), 1 male.

Erax loewii Bellardi, 1862. Saggio di ditterologia Messicana, Appendice: 21. Tela, Jilamo farm, May 28, 1923 (Hubbell), no. 657, 1 male.

Erax stylatus (Fabricius), 1775. Systema entomologiae: 795 (*Asilus*). Tela., Guaimas Dist., May 7, 1923 (Hubbell), no. 491, 1 male, May 10, 1923 (Hubbell), no. 527, 1 male, 1 female, May 5, 1923 (Hubbell), no. 470, 1 female, May 10, 1923 (Hubbell), no. 508, 1 male, May 3, 1923 (Hubbell), no. 452, 1 male, 1 female, and May 8, 1923 (Hubbell), no. 492, 1 female.

Erax poecilolamprus, n. sp.

A member of Hine's *aestuans* group. The legs are wholly black, the femora with a strong metallic blue reflection visible only under certain lights; the male costa is expanded; in the male, the sixth, seventh, and the apex of the fifth tergum are silvery; in the female, the eighth abdominal segment is approximately equal in length to the fifth, sixth, and seventh combined.

Male.—Head black, pale yellowish pollinose on front and face, whitish pollinose on the occiput. Mystax moderately dense: a group of 20–25 black bristles and bristly setae on its upper part and a row of stiff black bristles on the oral margin (sometimes only the lateral ones of this row are black); setae, hairs, and bristles of mystax otherwise yellow. Ocellars black; hairs of vertex mostly black, those of front and occiput mixed black and yellow. Occipital hairs and bristles yellow; a group of three to five stiff bristles with curved tips on each side of the vertex and some adjacent hairs black; an occasional black bristle in the postocular row. Beard rather dense, composed of soft, yellowish, mostly plumose hairs. Antennae black; first and second segments with yellow setulae below, black above; arista 2 to 2½ times as long as the rather short flagellum. Palpi with black and yellow bristles intermixed. Proboscis shining blue-black; some long yellow hairs below.

Thorax black; mesonotum with yellowish pollen, somewhat brassy in certain reflections, anteriorly, which merges into cinereous on the posterior part of the mesonotum, the scutellum, and the pleura; this cinereous pollen, especially on the mesonotum, with brassy to purplish reflections in certain lights; mesonotum with a broad median geminate stripe and to each side of it an oval area, interrupted about medially by the suture; these areas subshining, somewhat bluish in certain reflections, and extending to the posterior declivity of the mesonotum; posterior declivity with three triangular black spots, one above each postalar callus and one medially above the base of the scutellum; in certain lights these are confluent with the middorsal stripe and lateral spots. Some stiff black bristles on the pronotum. Bristles and hairs of mesonotum mostly black; some yellowish hairs on anterior margin, humeri, and above wing bases. Scutellum black-haired on disc, more or less broadly yellow-haired laterally and apically; two to three apical bristles on each side, black, sometimes in part yellow. Pile of prothorax yellow; that of upper parts of pleura generally black, of lower parts generally yellow.

Legs wholly black; femora in certain lights with brilliant metallic blue reflections; coxae cinereous pollinose, legs otherwise subshining. Coxae with yellow hairs and bristles; bristles of legs otherwise at least mostly black; femora with yellowish hairs below, especially long and dense on the front pair, less so on the middle and least so on the hind pair; front and hind tibiae and tarsi with dense, velvety golden pile ventrally; hairs of legs otherwise at least mostly black. Wing venation essentially as in *aestuans*; costa expanded; second submarginal cell with a distinct though short stump-vein basally; membrane brownish, distinctly darker near apex. Halteres yellow.

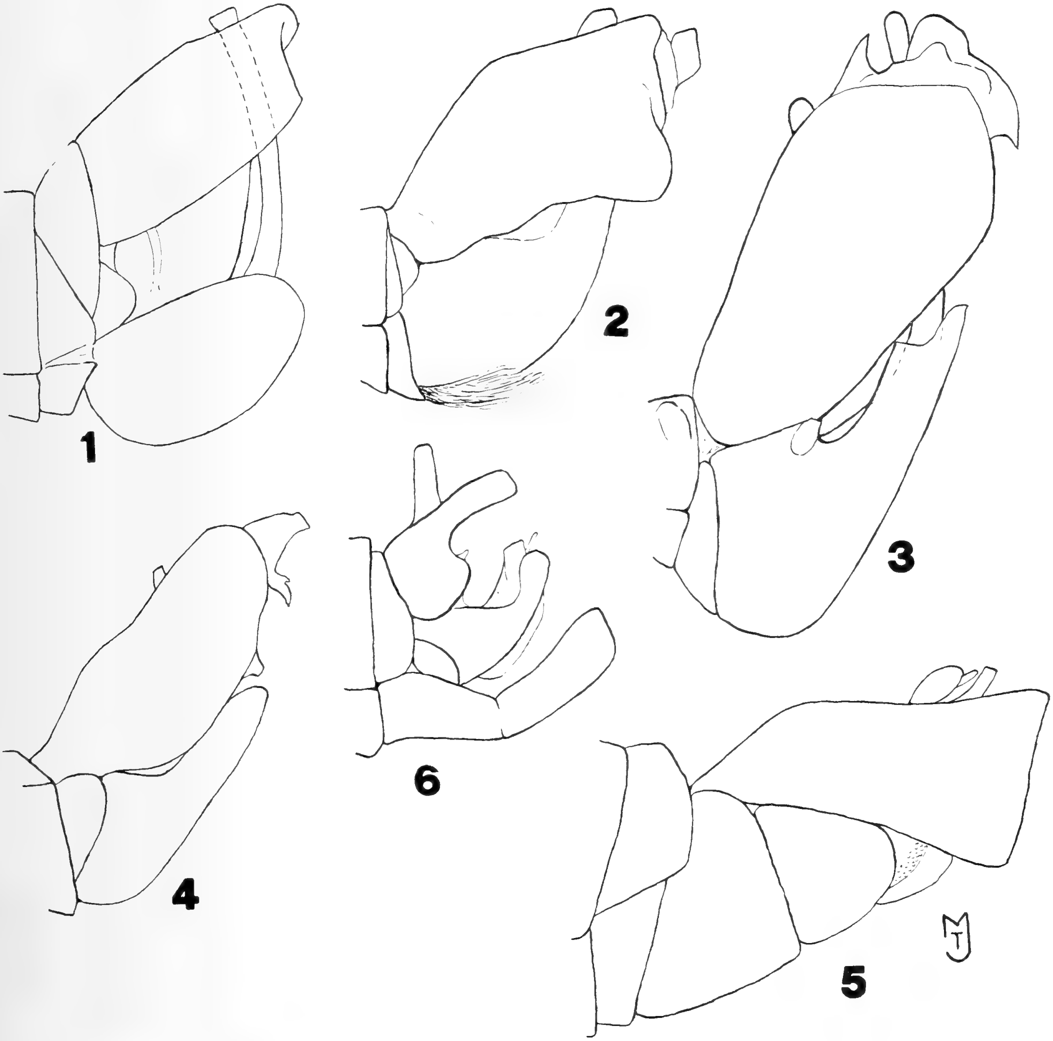
Abdomen black, the apices of terga 2, 3, and 4 brownish; first segment cinereous pollinose; terga 2 to 4 mostly subshining black, the sides broadly cinereous, tergum 4 tending to opaque brownish; tergum 5 brownish black, the sides broadly cinereous and the apex densely silvery; 6 and 7 densely silvery; sterna cinereous, tending to silvery on 6 and 7. Three to four long black (sometimes at least partly yellow) bristles on each side of tergum 1; some short appressed black hairs on the posterior part of tergum 3 and on the discs of 4 and 5; only scattered white hairs on the silvery areas; hairs otherwise yellow. Eighth sternite cinereous, not at all posteriorly directed, but with a dense tuft of posteriorly directed black crinkly hairs at its middle apically. Genitalia shining black with bluish reflections as on the mesonotum (not so strongly metallic as on the femora); hypopygium (Fig. 2) broad from lateral view, truncate and tuberculate apically, with a tuft of black dense inwardly directed hairs on each lower apical margin; genitalia otherwise with scattered hair, mostly black except apically, where it is yellow.

Length, 18–20 mm.

Female.—Wing without costal expansion and with a longer stump at the base of the second submarginal cell; brownish clouding not so apparent as in the male. Abdominal terga 2 to 6 in coloration similar to 2 to 4 in the male; 7 to 9 shining, 8 about equal in length to 5, 6, and 7 combined. Otherwise except sexually as described for the male.

Types.—Holotype, male, Tela, Honduras, May 12, 1923, no. 535 (T. H. Hubbell). Allotype, female, same data but May 3, no. 452. Paratopotypes: 2 males, 2 females, same data as holotype; 1 male, same data as allotype; 2 males, 2 females, same data but May 10, no. 527; 1 male, 1 female, same data but May 8, no. 492; 1 male, same data but May 7, no. 491; 2 females, same data but May 10, no. 512; 1 male, same data but May 5, no. 470; 1 female, same data but May 10, no. 508; 1 female, same data but May 1, no. 414. Paratype, 1 male, Aguan River Valley, Maloa farm, Honduras, April 24, 1923 (Hubbell).

Remarks.—Several neotropical *Erax* of the *aestuans* group have wholly black legs with golden-matted front and hind tibiae and tarsi, and, from their descriptions, seem similar to this



Figs. 1–6.—Male genitalia, side view; pilosity and bristles omitted except ventral tuft in Fig. 2: 1, *Eicherax flavescens*, n. sp., from holotype; 2, *Erax poecilolamprus*, n. sp., from paratype; 3, *Erax cockerellorum*, n. sp., from holotype; 4, *Erax hubbelli*, n. sp., from holotype; 5, *Proctacanthus caudatus* Hine; 6, *Pachychoeta complicata*, n. sp., from paratype.

species. Two of these are keyed out by Hine (1919, pp. 107, 120), but *loewii* Bellardi(=*dolichogaster* Williston) has only the seventh and the posterior margin of the sixth male terga silvery; *mexicanus* Hine is smaller, has male terga five to seven silvery, and has the seventh male sternum strongly produced apically; both these species have male genitalia different from those of *poecilolamprus*. Of Bromley's Brazilian species *neowillistoni* (=*willistoni* Bromley, *nec* Hine) and *latiforceps* have three submarginal cells; *subchalybeus* has the beard, postgenal hairs, and pruinosity of the face and occiput white, the ensemble giving the insect a light bluish-gray appearance; and *chapadensis* lacks the dilation of the male costa.

Erax cockerellorum, n. sp.

Referable to Hine's *carinatus* group, though with a poorly developed mesonotal mane. A black species with golden to violaceous (depending on the light) thoracic pollen, black legs except the larger part of the tibiae, an expanded male costa, and silvery pollinose sixth and seventh male terga.

Male.—Vestiture of head mostly black, but prominently yellow in places. Facial tubercle prominent; mystax composed of black hairs and bristles except a small tuft of yellow hairs on its upper part and a more prominent tuft of yellow bristles above middle of oral margin. Beard composed of yellow plumose hairs; a few yellow hairs at middle of occiput above; pile and bristles of head otherwise black, including three to five moderately stout occipital bristles on each side above. Color of pollen of head hard to determine but apparently as in the female. Antennae black, wholly black-haired; flagellum lanceolate, about two-fifths length of arista; first segment a little longer than flagellum. Palpi black-haired.

Mesonotum dorsally compressed and typical of the *carinatus* group but with at most a very feebly developed crest; an abundance of bristles behind the suture. Tomentum golden, in some lights violaceous; a median black vitta divided anteriorly by an area of pale tomentum. Scutellum with three marginal bristles on each side, these variably black or yellow, and with an abundance of moderately long pile which is black medially and yellow laterally. Hypopleura with each a tuft of yellow hairs, pile and bristles of pleura otherwise black. Legs mainly black; tibiae mainly bright yellow, apices black, strongly contrasting; front coxa with white and yellow hairs; some yellow hairs at base of front femur below and of middle femur below and laterally: front and hind tibiae with dense short golden pile, middle tibia with longer, more scattered hairs inwardly, that on the hind tibia apically and extending onto the first two tarsal segments golden-brown; bristles and pile otherwise black, with some golden or yellow intermixed; the prevailing appearance of the vestiture of the legs, except when the insect is viewed anteriorly, being black. Wings distinctly brown, the veins black; costa expanded; stump vein at base of second submarginal cell very short. Halteres yellow.

Abdomen with sixth and seventh terga silvery and genital segments shining black; pollinose pattern otherwise hard to distinguish, but sterna, first tergum, and sides of second to fifth terga inclusively apparently cinereous. Pile mixed black and yellow on tergum 1, long and black on sterna 1, 2, 7, and 8, long and white on other pregenital sterna and on sides of terga 2 and 3, short and white on tergum 6, otherwise short and black; most genital pile black; a mane of dense, crinkly black hairs on each process of the ninth sternite. Hypopygium (Fig. 3) robust.

Length, 19 mm.

Female.—Pollen of head mostly golden, except that that just above the antennae and on the facial prominence is cinereous. Mystax with upper tuft of hairs as in the male but with bristles above the oral margin, except one aberrant one, black. Very few pale hairs at bases of front and middle femora. Costa not expanded and stump vein at base of second submarginal cell much longer than the vein connecting it with the radial sector. First and second abdominal segments brownish pollinose; apex of second tergum, third and fourth terga except a large dorsal arrowhead-shaped marking, pointed apically, on each, the moderately interrupted basal and partial lateral margins of the fourth tergum, a small sublateral basal spot on the fifth tergum, the apex of the second, base of the fifth, and all of the second, third, and fourth sterna, cinereous pollinose; eighth segment shining; the remaining parts of the abdomen subshining, black. Eighth segment slightly longer than the fifth, sixth, and seventh combined. Otherwise, except sexually, as described for the male.

Types.—Holotype male, allotype female, Uroca Peak, Honduras, March 9, 1947 (Morelos):

State College of Washington type collection no. 173. The holotype is somewhat "greased," so that part of the pollinose pattern is hard to distinguish, but otherwise it is in good condition.

Remarks.—This species seems to fit best in Hine's *carinatus* group. The mesonotum is compressed as in the more typical members of that group, but the mesonotal crest is very feeble, in fact, hardly discernible. In Hine's key (1919, pp. 107, 131) it runs best to *jubatus*, with which it agrees in having the vestiture of the pronotal declivity entirely black; *jubatus* has a strong crest, however, and differs otherwise in color characters. The male genitalia are of the same general type as those of *jubatus*, though they are more robust and differ considerably in detail. The mesonotum is more strongly compressed than in members of the *barbatus* group and the vestiture of the mesonotal declivity and of the scutellum is longer and denser.

Erax hubbelli, n. sp.

Best referable to Hine's *carinatus* group, although the lack of a mesonotal crest suggests the *barbatus* group. A black species with bicolored tibiae, coppery thoracic pollen, an expanded male costa, and silvery pollinose sixth and seventh abdominal segments in the male.

Male.—Pollen of head yellowish, becoming coppery on front and vertex and on face above facial prominence, more cinereous on facial prominence and along inner occipital orbits. Facial prominence strong. Bristles of mystax black on upper, white on lower half; smaller hairs of face mixed black and white; those above antennae and on ocellar triangle black, long. Beard white, occiput mostly with white vestiture, most of the setae of the postocular fringe and a group of four to six bristles on each side above, and occasionally some of the adjacent hairs, black. Antennae black with black hairs; ratio of first, second, and third antennal segments and of arista 12: 5: 10: 25. Palpi with black hair and bristles. Proboscis shining, a tuft of stout white setae below and some short white hairs apically.

Thorax with coppery pollen which becomes yellowish on lower parts of pleura and cinereous on mesonotal declivity over an indefinite area in front of the scutellum; pollen of scutellum cinereous, yellowish at base; a geminate median vitta and three triangular spots on the mesonotal declivity, one above each wing base and one above the middle line of the scutellum, devoid of pollen; a lateral oval spot on each side of the mesonotal vitta, interrupted at the suture, appearing pollinose only under certain lights. Prothorax with black bristles and with white pile anteriorly and black posteriorly; scutellum with long white crinkly pile and with two to four bristles, usually black, on each side; thorax otherwise chiefly with black hair and bristles. Legs chiefly black; tibiae reddish yellow, distinctly black apically and less distinctly so basally except on the hind pair; bristles of legs black; pile and setulae of coxae yellow, more whitish toward median line of body, those of the underside of the middle and fore femora basally whitish; pile of inner side of fore and hind tibiae and basitarsi dense, short, velvety, golden; vestiture of legs otherwise mainly black, in many places with pale pile intermixed. Wings with a slight tinge of brown; costa inflated; stump vein of second submarginal cell very short.

Abdomen slender; sixth and seventh segments wholly densely silvery pollinose; first segment, sides of terga 2 to 5, and sterna 2 to 5, cinereous pollinose; terga 2 to 5 subshining medially. A few black bristles laterally on each side of tergum 1, terga 4 and 5 with short black hairs, terga 6 and 7 with short silvery hairs; pregenital segments otherwise with rather long crinkly whitish hairs. Eighth sternum transverse, not produced apicad. Eighth segment and genitalia shining black, the hypopygium (Fig. 4) largely bluish-black. Ninth sternum with a dense ventral crest of black, crinkly hairs. Vestiture of genitalia black.

Length, 18 mm.

Types.—Holotype male, Mount Caculatepe, Morazán, Honduras, 4,200–4,500 feet, August 6, 1948 (T. H. Hubbell), no. 203, University of Michigan Museum of Zoology. Paratype, male, Escuela Agrícola Panamericana, Zamorana, Mount Caculatepe, Morazán, Honduras, 4,600–5,200 feet, August 6, 1948 (Hubbell), no. 204.

Remarks.—In Hine's key (1919, pp. 107, 108, 131) this species runs to *bicolor* Bellardi, if traced to the *barbatus* group, where the lack of a mesonotal crest would tend to place it, or to couplet 6 of the *carinatus* group, where the lack of a crest would prevent it from tracing further. *E. bicolor* is quite a differently appearing species, with a more evenly rounded mesonotum, a distinctly grayish pollinose body, a predominantly white pile, and a different hypopygium.

This species, in which the mesonotal crest is lacking, and the preceding one, in which it is feeble, do not fit well into the *carinatus* group, as Hine defines it. However, among the species which Hine refers to that group, the crest varies considerably in its density, from a very heavy one in such species as *jubatus* Williston and *subcupreus* Schaeffer to a thin one in *cressoni* Hine. In the light of this fact, *cockerellorum* and *hubbelli* do not seem so anomalous. In these two species, as in other members of the group, the facial prominence is very sharply defined, especially above; the third antennal segment is short, lanceolate, and not more than two-fifths the length of the arista; the hairs of the mesonotal declivity and of the scutellum are long and dense; the number of scutellar bristles is small, usually not more than six; the wing of the male has an expanded costa and a very short, sometimes evanescent, stump-vein at the base of the second submarginal cell; and the male genitalia fit a common pattern.

Erax unicolor Bellardi, 1861. Saggio di ditterologia Messicana 2: 37. Zamorano, January 1, 1947 (Cisneros), 1 male, and December 17, 1946, 1 female; Agua Amarilla, December 15, 1946, 1 male.

Erax argyrogaster Macquart, 1846. Dipteres exotiques, Suppl. 1: 84. Negrito, March 27, 1923 (Hubbell), no. 148, 1 male, 2 females.

Erax interruptus (Macquart), 1834. Histoire naturelle des diptères **1:** 310 (*Asilus*). Escuela Agrícola Panamericana, Zamorano, Morazán, July 26, 1948 (Hubbell), 2,600 feet, plain, no. 146, 1 male; same, July 10, 1948 (Hubbell), plains, 2,700 feet, no. 50, 1 male, 2 females; same, July 11, 1948 (Hubbell), flats, Yeguare River, no. 59, 1 female; Galeras, October 19, 1946 (G. Vidales), 1 female.

Erax triton Osten Sacken, 1887. Biologia Centrali-Americana, Diptera, **1:** 200. Zamorano, March 28, 1947 (Adan Oseguero).

Pachychoeta complicata, n. sp.

A black species with predominantly yellow legs, yellowish-brown mesonotal pollen, and lightly infumated wings.

Male.—Head black, the pollen mostly white with a slightly yellow cast, that on the front and vertex distinctly yellow. Bristles and setulae of front, vertex, upper part of occiput, uppermost part of mystax, first two antennal segments, and, in part, of palpi, black; the short hairs near apex of proboscis yellow; vestiture of head otherwise white. Ratio of antennal segments and arista 16: 7: 11: 37; arista distinctly though narrowly flattened apically and terminating in a lanceolate process followed by a short spine. Antenna mostly black, the second segment and the third in part reddish.

Thorax black, the pale-pollinose areas yellowish brown on mesonotum, upper parts of pleura, and base of scutellum, the pollen otherwise whitish with yellow reflections; mesonotum with a median broad blackish-pollinose (reddish brown in some lights) geminate stripe extending from its anterior margin to a point halfway from the suture to the scutellum; an oval presutural and a similar postsutural spot on each side; behind these, a triangular spot on each side and a median prescutellar triangle. Vestiture black on mesonotum, scutellum, and uppermost parts of mesopleura; a few yellow pronotal bristles; vestiture otherwise white.

Legs largely reddish yellow; coxae and trochanters black, pollen as on thoracic pleura; extreme apex of middle and apical third to half of hind femur blackish; hind tibia blackish on approximately the apical half; front and middle tarsi brownish beyond the basitarsi, hind tarsus wholly brownish. Fine, erect hairs of legs mostly pale, the appressed and stiffer ones, however, black; hind femur with both black and yellowish appressed hairs, however; bristles mostly black except on fore femur; front and hind tibiae and tarsi with matted yellow to golden pile below. Halteres yellow. Wings lightly infumated, distinctly darker posteriorly and apically.

Abdomen black; apex of first, sides of second to fifth, and venter of first to fifth segments, whitish pollinose; terga 1 to 5 on disc brownish-black pollinose, this pollen extending, in a paler color, onto disc of tergum 6 at its base and, very narrowly, onto base of tergum 7; apices of terga 2 to 5 lighter brown pollinose; segments 6 and 7 ventrally and, except as noted above, dorsally, silvery pollinose. Long pile on sides and venter, especially toward base of abdomen, and bristles at apices of segments, white; appressed hairs of terga mixed black and white. Genitalia as in Fig. 6; shining, mostly black, the inner parts reddish, blackish to reddish-brown pilose; hypopygium basally on dorsal side with a dense tuft of long black bristles and ventrolaterally on the bulbous part with a group of five to six very long black bristles and several shorter hairs, its terminal digitate process with curly, moderately short, reddish brown hairs below; ninth sternite prolonged beyond other terminalia, provided with long dense reddish brown hairs laterally and apically, a few black bristles ventrally at the apex, and with mostly black hairs and setulae on its ventral surface.

Length, 17 mm.

Types.—Holotype male, Tela, Guaimas Dist., May 10, 1923 (Hubbell), no. 508; University of Michigan Museum of Zoology. Paratypes: male, same data; male, same data but May 2, 1923, no. 436.

Remarks.—This species agrees in most respects with the description and figures of *Erax annulipes* (Brazil) given by Macquart, so far as the description of a female may fit a male; however, in *annulipes* the wing is figured and described as being uniformly infumated and the thorax and abdomen are said to be gray-pollinose. In view of these discrepancies, I feel reasonably safe in considering the present form distinct.

Proctacanthus caudatus Hine, 1911, Ann. Ent. Soc. Amer. **4:** 159. The series before me seems to be this species, the only discrepancy with Hine's description being that the mystax is partly black; the extent of the black is variable, however, in these five specimens, no two being alike; the black may be limited to *most* of the strong bristles on the oral margin, at one extreme, or, at the other, may involve also most of the setulae above this row. Curran (1934a) does not include *caudatus* in his key; depending on whether the mystax were partly black or wholly yellow, it would run to *dina* Curran, couplet 9, except that the apical lamellae of the ovipositor have only marginal spines, or to *fulviventris* Macquart, from which Hine's key will readily separate it. In the series before me, all thoracic bristles and all hairs and setulae of the mesonotum and scutellum are black; the hairs and setulae of the vertex and, in general, of the upper parts of the pleura, part of the pronotal vestiture, the postocular bristles, and, usually, the tuft of two to four bristles arising among the pale hairs at the sides of the first abdominal segment, are black. The pale pollen of the mesonotum varies from gray to chocolate brown. The male genitalia are as in Fig. 5; the hypopygium is black-haired above, yellow-haired below.

Honduras records.—Tela, May 5, 1923 (T. H. Hubbell), no. 478, 1 male; Tela, May 21, 1923 (Hubbell), no. 601, 1 male; Tela, July 5, 1924, 1 male, 1 female, in copula (U. S. National Museum); Escuela Agrícola Panamericana, Zamorano, July 24, 1948 (Hubbell), 2,250 feet, flat Yeguare River, no. 141, 1 male.

Promachus cinctus Bellardi, 1861. Saggio di ditterologia Messicana **2:** 25. Tela, Guaimas Dist.: May 5, 1923 (T. H. Hubbell), no. 470, 1 female; May 2, 1923 (Hubbell), no. 442, 1 female; May 10, 1923 (Hubbell), no. 529, 1 female; May 9, 1923 (Hubbell), no. 505, 1 male; May 8, 1923 (Hubbell), no. 492, 1 male; May 10, 1923 (Hubbell), no. 508, 1 female; May 12, 1923 (Hubbell), no. 535, 1 female; May 9, 1923 (Hubbell), no. 497, 1 male. Progresso, May 1, 1923 (Hubbell), no. 497, 1 male.

Promachus forfex Osten Sacken, 1887. Biologia Centrali-Americana, Diptera; **1:** 194. Tela, Guaimas Dist., May 10, 1923 (T. H. Hubbell), no. 508, 1 male.

Promachina trapezoidalis (Bellardi), 1861. Saggio di Ditterologia Messicana **2:** 28 (*Promachus*). Tela, Guaimas Dist.: May 3, 1923 (T. H. Hubbell), no. 452, 1 female; May 2, 1923 (Hubbell), no. 440, 1 male, 2 females; May 9, 1923 (Hubbell), no. 497, 2 females; May 12, 1923 (Hubbell), no. 535, 1 female; May 2, 1923 (Hubbell), no. 442, 1 male; May 10, 1923 (Hubbell), no. 527, 1 female. Progreso, May 1, 1923 (Hubbell), no. 544. Choluteca River bridge, Tegucigalpa-Danli Road, 1,950 feet, El Paraíso Dist., July 25, 1948 (Hubbell), no. 142, 1 male.

Mallophora freycineti Macquart, 1839. Diptères exotiques **1**(2): 85. Zamorano, March 28, 1947 (Salazar), 1 male.

Mallophora sp. This species traces to *abana* Curran in Curran's key (1934b), but it does not fit the description of that species. It is probably new, but I do not feel secure in describing it as such. Tela, Guaimas Dist., May 3, 1923 (T. H. Hubbell), no. 452, 1 male.

Atomosia hondurana, n. sp.

Close to *rufipes* Macquart, but with about the apical half of the hind tibia, a preapical band on the hind femur, at least the last two tarsomeres of the hind tarsus, and the postalar callus black.

Male.—Head black, entirely covered with pollen which is yellowish on the vertex and upper occiput, otherwise silvery; mystax, beard, and pile of palpi and proboscis white; that of vertex and antennae yellow, except that it becomes black at the apex of the first and second antennal segments; ocellar bristles one pair, yellow; first antennal segment with an outstanding yellow bristle. Antennae structurally as in *rufipes*, elongated, first segment about twice second in length, third with the short dorsal spine a little beyond its middle; black, second segment reddish. Palpi black; proboscis shining black.

Thorax including postalar callus wholly black; mesonotum with appressed brassy tomentum and with semierect hairs on middle line and in dorsocentral rows; mesonotum from posterior view appearing to have two longitudinal tomentose vittae. Scutellum with two pairs of marginal bristles, the outer ones small and sometimes difficult to distinguish. Pleura silvery-pollinose, hairs mostly white, those on upper part more yellowish. Coxae black, silvery pollinose and pilose; front and middle femora and tibiae wholly yellow with white to yellow hairs and bristles; hind femur with a broad preapical black annulus, otherwise yellow; hind tibia black on the apical half or sometimes more, otherwise yellow; pile of legs mostly white, bristles white to yellow; a fringe of white hairs ventrally on the hind tibia and femur, denser on the former. Front and middle tarsi each with apical tarsomere black with black hairs, otherwise yellow with yellow hairs and bristles; hind tarsus with usually last four tarsomeres wholly black, at least above, the hairs and bristles mixed black and yellow. Wings hyaline, veins brown; first posterior cell usually closed in the margin.

Abdomen black, shining bluish in certain lights; terga 2 to 5 very narrowly margined posteriorly with silvery pollen, the margins a little broader laterally; brassy yellow tomentum dorsally on the segments, white pile laterally and ventrally. Hypopygium black; genitalia ventrally yellow, yellow-haired.

Length, 8 mm.

Female.—Very much like the male, but on the average slightly larger and a little more robust.

Types.—Holotype male, Escuela Agrícola Panamericana, Zamorano, 2,600 feet, at light, July 14, 1948 (T. H. Hubbell); University of Michigan Museum of Zoology. Allotype female, same data but July 11, 1948, on gardenia (Hubbell), no. 58. Paratopotypes: 5 females, same data as allotype; 2 males, 3 females, July 4, 1948 (Hubbell), on gardenia, no. 25; 3 males, 5 females, July 9, 1948 (Hubbell), tall weeds, no. 45; 1 male, July 2, 1948 (Hubbell), 2,550 feet, flats, Yeguare River, no. 18; 1 male, Aug. 16, 1948 (Hubbell), on citrus, no. 225; 1 female, July 1, 1948 (Hubbell), roadside, no. 10; 1 female, July 29, 1948 (Hubbell), thicket, no. 162.

Remarks.—There is some variation in the color of the legs. The hind tarsus is usually as described, though the black may exceptionally be limited to the last two or three segments. The black on the hind tibia and femur may be more extensive, so that the segments may be more than half black. The black coloration is usually quite distinct and may have a metallic blue sheen.

In Curran's (1930) key this species traces to *tenuis* Curran from Brazil, from which it may readily be distinguished by the wholly pollinose vertex, occiput, and pleura; in Hermann's (1912) key it runs to *glabrata* (Say), but in that species the first antennal segment is shorter and the pattern of leg coloration is different. The brief original description of *anonyma* Williston agrees with my specimens, so far as it goes, but according to Curran's key *anonyma* has six or more ocellar bristles. The closest relationship, so far as I can determine, is with *rufipes* Macquart and species of that complex; this may be a subspecies of *rufipes*.

Cerotainia minima Curran, 1930. Amer. Mus. Nov., no. 425: 12. Escuela Agrícola Panamericana, Zamorano, Morazán: July 9, 1948 (T. H. Hubbell), tall weeds, no. 45, 3 males, 3 females; July 19, 1948 (Hubbell), weed thicket, no. 106, 2 males, 8 females; July 22, 1948 (Hubbell), herbage and brush, no. 125, 1 male; July 6, 1948 (Hubbell), on rose, 2 females; July 15, 1948 (Hubbell), on citrus, no. 76, 1 female; July 1, 1948 (Hubbell), roadside, no. 10, 1 female. Zamorano, October 10, 1946, (Cisneros), 1 female; October 1946 (A. Carr), 1 female.

Cerotainia ornatipes, n. sp.

A black species with robust females, more slender males; the thorax thickly and entirely black-haired; the tarsi, except the apical segment of each, yellow, those of the male, especially the fore and middle pair, with appressed silvery hairs apically; the wing strongly clouded on the basal half.

Male.—Head black, covered with an ochraceous pollen anteriorly and on the vertex and a silvery pollen on the occiput; mystax white with a few scattered black bristles; pile of head otherwise mostly white, the beard silvery; ocellar bristles two, yellow, in addition a few yellowish hairs on the ocellar triangle; occipital bristles black, not rising from tubercles. Antennae elongated, structurally much as in *dasythrix*; first segment eight to nine times as long as wide, about four times length of second; third segment missing in both males of the type series, presumably much as in the female; antennae black, black-haired, the first segment with an outstanding black, bristle below, the second with one below and one above. Proboscis black, black- and white-haired.

Thorax entirely black; mesonotum and scutellum with distinct bluish reflections when viewed under magnification; prothorax except pronotal collar, humeri, pleura, and metathorax pollinose, the pollen mostly ochraceous; all thoracic bristles and pile black, that of the mesonotum erect and dense; scutellum with an apical fringe of hairlike bristles which are distinctly longer than the pile of the disc. Mesopleura only moderately convex, not unusually swollen. Coxae black, ochraceous pollinose; femora black with bluish reflections as on the mesonotum; tibiae yellow with considerable infuscation, the hind one with a weak bluish reflection; tarsi bright yellow except apical tarsomere of each, which is black. Pile and bristles of fore and middle tarsi yellow, the pile becoming silvery and appressed dorsally on the last two tarsomeres; bristles of hind tarsus black, its pile yellow ventrally, black dorsally on the basal tarsomeres, with some yellow pile on the third and some yellow and silvery on the last two tarsomeres; pile and bristles of the coxae, femora, and tibiae wholly black. Wing distinctly brown at base and along costal margin, gradually becoming subhyaline apically and posteriorly. Halteres infuscated.

Abdomen elongated, tapering almost to a point; terga black with reflections as on the mesonotum, sterna densely ochraceous pollinose; vestiture black, with quite a few rather inconspicuous yellow appressed hairs on the fifth and sixth terga. Genitalia yellow, yellow-haired.

Length, 6–6.5 mm.

Female.—More robust than the male, especially the abdomen. Ratio of antennal segments 55: 15: 70. Pile of tarsi black dorsally, yellow ventrally; no silvery tarsal pile as in the male. Abdomen oval.

Types.— Holotype, male, Zamorano, January 14, 1947 (W. P. Cockerell); State College of Washington Type Collection no. 174. Allotype female, Zamorano, January 29, 1947. Paratopotypes: 2 females, Zamorano, December 7, 1946 (W. P. Cockerell) and December 25, 1946 (T. D. A. Cockerell); 1 male, January 29, 1947.

Remarks.—The relationship to *C. dasythrix* Hermann seems to be very close. It traces there in both Curran's (1930) and Hermann's (1912) keys, and the antennal structure is precisely as illustrated by Hermann. According to the description of *dasythrix*, however, in that species the mystax and the pale vestiture of the head are yellow, there is a transverse band of golden hair behind the humeri, the tarsi are (wholly?) reddish brown and only the middle pair has silvery hair dorsally, and the body has a dark green (thorax) or brownish green to violet (abdomen) reflection.

Taracticus argentifacies, n. sp.

A black species with predominantly black legs, predominantly silvery pollinose head and thorax, and small spinelike setulae forming most of the mesonotal vestiture.

Male.—Head black, almost wholly covered with silvery pollen which is densest on the face and lower part of the occiput; the ocellar triangle at most in part subshining posteriorly. Mystax and beard white; bristles of occipital fringe yellow; ocellar triangle with one or two (one on one side, two on the other, in the type) pairs of small yellow bristles. Palpi and proboscis shining black with white hairs, the short ones at the apex of the proboscis yellow. Antennae black; the dorsal spine of the third segment set at about three-fifths the length of the segment.

Thorax wholly black. Prothorax mostly silvery pollinose with white hairs and yellow pronotal bristles. Mesonotum largely lightly silvery to cinereous tomentose; posterior part of humerus, a rectangular presutural lateral area, a small spot above the wing base, the postalar callus, and a preapical rim of the scutellum, shining; a pair of yellowish-pollinose stripes on the mesonotum, arising behind the suture and bowed strongly outward toward the humeri, contrasting with the rest of the mesonotal pollen. (The exact extent of the mesonotal and scutellar pollen is a little hard to determine because parts of these areas have been smeared with adhesive.) Mesonotum provided with numerous yellow spinelike setulae or short stout bristles and with hardly any softer hairs; hairs and bristles of pleura white. Scutellum with one pair of small yellow bristles. Legs mainly black, shining or subshining except the coxae; knees and bases of the hind femur, tibia, and basitarsus yellow; pile and bristles of legs yellow. Wing hyaline, the veins brown; fourth posterior cell very little narrowed. Halteres yellow.

Abdomen mostly black, seventh and genital segments yellow; terga with numerous setulose punctures, the setulae yellow to golden, laterally becoming pale yellow to white toward the base of the abdomen. Terga 1 to 4 each with a transverse rectangular silvery-pollinose spot apically on each side, these spots confined to about the lateral fourth of the segments; a very small round spot, removed from both apical and lateral margins, representing a remnant of such a spot on tergum 5; sterna cinereous-pollinose with scattered, fine white hairs. Genitalia yellow, yellow-haired.

Length, 7 mm.

Type.—Holotype male, Dept. Morazán, ridge between La Montañita and C. Uyuca, 5± km southwest of Suyapa, 5,200-5,400 feet, August 5, 1948 (T. H. Hubbell), fir woods; Museum of Zoology, University of Michigan.

Remarks.—In Pritchard's (1938) key this species runs to *vitripennis* (Bellardi) from which it may readily be distinguished by the ochraceous face, the mostly shining mesonotum, and other characters. If the small pollinose area on the fifth tergum is taken into consideration in Pritchard's key, this species will run to *nigripes* Williston, from which the bare ocellar triangle, the ochraceous thoracic pollen, the silvery lateral bar of the sixth abdominal segment, and other characters will distinguish it. The relationship to *nigripes* seems to be very close.

Andrenosoma (*Pilica*) *erythrogaster* (Wiedemann), 1828. Aussereuropäische Zweiflügelige Insekten **1:** 523 (*Laphria*). Tela, Guaimas Dist., May 5, 1923 (T. H. Hubbell), no. 478, 1 male, no. 470, 1 female; same, May 3, 1923 (Hubbell), no. 452. 1 female.

Laphria marginalis Williston, 1901. Biologia Centrali-Americana, Diptera, **1:** 318. Negrito, March 19, 1923 (T. H. Hubbell), no. 128, 1 female.

Lampria (*?mexicana* Macquart), 1847. Dipteres exotiques, Suppl. 2: 37. Tela, May 27, 1923 (T. H. Hubbell), Jilamo farm, no. 645, 1 female.

Aphestia nigra Bigot, 1878. Ann. Soc. Ent. France (5) **8:** 235. Tela, Guaimas Dist., May 3, 1923 (T. H. Hubbell), no. 452, and May 5, 1923 (Hubbell), no. 473, 1 male, 1 female.

Psilicurus caudatus Williston, 1901. Biologia Centrali-Americana, Diptera, **1:** 308. Tela, Guaimas Dist., May 1, 1923 (T. H. Hubbell), no. 414, 1 female, May 3, 1923 (Hubbell), no. 452, 1 male, and May 10, 1923 (Hubbell), no. 527, 1 male.

Stichopogon trifasciatus (Say), 1823. Journ. Acad. Nat. Sci. Philadelphia **3:** 51 (*Dasypogon*). Zamorano, December 6, 1946 (W. P. Cockerell), 1 male; Progreso, March 28, 1923 (Hubbell), no. 150, 1 male; Tela, March 10, 1923 (Hubbell), no. 47, and May 21, 1923 (Hubbell), no. 596, 2 females.

Holcocephala deltoidea (Bellardi), 1861. Saggio di ditterologia Messicana **2:** 85 (*Discocephala*). Zamorano, January 15, 1947 (Dorothy Wiley), 1 male.

Holcocephala oculata (Fabricius), 1805. Systema antiliatarum: 151 (*Dioctria*). Tela, April 28, 1923 (T. H. Hubbell), no. 406, 1 male; Tela, Guaimas Dist., March 17, 1923 (Hubbell), no. 115, 1 male; Río Claura, April 13, 1923 (Hubbell), no. 264, 1 female.

Holcocephala affinis (Bellardi), 1861. Saggio di ditterologia Messicana **2:** 86 (*Discocephala*). Río Paulaya, Barranco, April 16, 1923 (Hubbell), no. 290, 1 female. The above specimen agrees with the characterization given by Pritchard (1938), who stated that the species had not been recognized again since its original description.

Diogmites ialapensis (Bellardi), 1861. Saggio di ditterologia Messicana **2:** 65 (*Saropogon*). Tela, Dakota farm, May 26, 1923 (T. H. Hubbell), no. 639, 1 male; Zamorano, Escuela Agrícola Panamericana, 2600′, July 1, 1948 (Hubbell), roadside, no. 10, and 2,550 feet, July 2, 1948 (Hubbell), flats, Yeguare River, no. 18, 2 females.

Lissoteles hermanni Bezzi, 1910. Boll. Lab. Zool. Generale e Agraria, Portici, **4:** 178. Bezzi described this species from a single female. My specimen fits his description very well except for the thoracic pattern, which may very well be subject to variation. Bezzi described the mesonotum as gray-tomentose with a pair of not very distinct brown longitudinal stripes which diverge anteriorly. My specimen has two crescentric brown spots behind the humeri; these may well be the diverging anterior arms of these stripes, which otherwise do not seem to appear. There is a small brown bar about half way between each humerus and the suture and removed some distance from the notopleural suture; just behind the suture and above the wing base there is a round subshining black spot bordered with brown pollen below. Bezzi described the scutellum as having no macrochaetae; it does, however, have numerous long erect hairs, especially toward its apex, some of which are almost bristlelike. Bezzi is uncertain about the abdominal pollen since in his specimen the abdomen is not in a good state of preservation ("greased"?). In my specimen the abdominal terga, especially 2 to 6 inclusively, are cinereous pollinose at the bases and sides, briefly so also apically, but with gray pollen, in places with somewhat of a yellow tinge, in the middle.

Honduras record.—Puerto Castilla, May 3, 1923 (T. H. Hubbell), no. 2, 1 female.

LITERATURE CITED

Bromley, S. W. *Asilidae*, in Curran, C. H., *The Diptera of Kartabo, Bartica District, British Guiana.* Bull. Amer. Mus. Nat. Hist. **66** (3): 327-360. 1934.

———. *The robber flies of Brazil.* Livro de homenagem a R. R. d'Almeida, no. 8: 103–120. 1946.

Carrera, Messias. *Synoptical keys for the genera of Brazilian "Asilidae" (Diptera).* Rev. Brasil. Biol. **10** (1): 99–111. 1950.

Curran, C. H. *New American Asilidae (Diptera).* Amer. Mus. Nov., no. 425: 1–21. 1930.

———. *The families and genera of North American Diptera*, 512 pp. New York, 1934.

Hermann, F. *Beiträge zur Kenntnis der südamerikanischer Dipterenfauna aus Grund der Sammelergebnisse eines Reise in Chile, Peru, und Bolivia. Asilidae.* Nova Acta Abh. Kais. Leop.-Carol. Deutsch. Akad. Naturf. **96:** 1–275. 1912.

Hine, James S. *Costa Rican Diptera collected by Philip P. Calvert, Ph.D., 1909–1910. Paper 2: Tabanidae and Asilidae.* Trans. Amer. Ent. Soc. **43:** 291–299. 1917.

———. *Robberflies of the genus* Erax. Ann. Ent. Soc. Amer. **12:** 103–157. 1919.

Pritchard, A. Earl. *Revision of the robberfly genus* Taracticus *Loew with descriptions of three new species (Diptera, Asilidae).* Journ. New York Ent. Soc. **46:** 179–190. 1938.

ZOOLOGY.—*Two new species of* Eulimnadia *from Maryland and Virginia (Crustacea: Conchostraca).* N. T. Mattox, University of Southern California.[1] (Communicated by Fenner A. Chace, Jr.)

During the course of studies of the conchostracan phyllopods in the collections of the U. S. National Museum two new members of the genus *Eulimnadia* were found. These animals were represented in 13 collections from temporary pools found in 3 different localities.

Eulimnadia ventricosa, n. sp.

Description.—Male: With characters of the genus (Packard, 1883, and Daday, 1926). The bivalve shell is amber colored, transparent, and elongately oval (Fig. 1, *a*). The dorsal margin is slightly rounded with the highest elevation (umbo) approximately two-fifths the length from the anterior margin. The ventral margin of the shell is greatly rounded, with the posterior end more truncate than the anterior. The length of the shell averages 8.5 mm with an average height of 5.2 mm. The lines of growth vary in number from 8 to 12, with the outer ones very closely spaced.

The head possesses the typical frontal organ (Fig. 1, *c*). The front is straight dorsally, but prominently extended ventrally forming a conspicuous rostrum. The scape of the second antennae extends beyond the tip of the rostrum. Each flagellum of the second antennae is variously spined and has nine segments, the posterior one being longer than the anterior. The first antennae are longer than in the female, extending to the distal end of the third segment of the flagellum of the second antennae. The first antennae possess 9 or 10 dorsal sensory papillae.

The body bears 18 pairs of swimming legs. The first and second pair are modified into the claw-like gnathopods typical of the genus. The two segments of the sixth endite of the first pair of gnathopods are of the same length (Fig. 1, *e*). The terminal segment of the sixth endite of the second gnathopod is approximately twice the length of the proximal segment and is much longer than that of the first gnathopod (Fig. 1, *f*). The posterior 10 to 12 body segments bear middorsal spines.

The telson is elongate, the ventral margin much shortened extending only one-third the distance of the dorsal margin (Fig. 1, *g*). The dorsal ridges of the telson are variously spined with 14 to 16 pairs of spines. The terminal telson

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[1] Department of Zoology, Allan Hancock Foundation. Allan Hancock Foundation Contribution No. 108.

claws are elongate and tapered, extending posteriorly to a distance equal to the length of the dorsal margin. The dorsal forked filament arises between the third and fourth pair of telson spines.

Female: The female shell is much more rounded, ventricose, in outline (Fig. 1, *b*). Both the dorsal and ventral margins are very rounded with the greatest height near the center. The length of the shell in mature females varies from 7.7 to 10.7 mm, and the height varies from 5.3 to 6.8 mm. The average size of those measured is 8.9 mm by 6.1 mm. The number of growth lines averages 10, with a variation of 8 to 12.

The front of the head is much less concave than in the male with the rostrum less pronounced (Fig. 1, *d*). The second antennae are similar to those of the male. The first antennae are much reduced, not extending beyond the distal end of the scape of the second antennae.

The swimming legs, 18 pairs, are unspecialized, being of the general, swimming type characteristic of the genus.

The telson is similar to that of the male with 14 to 19 pair of dorsal spines, 15 pairs is the average number.

Type locality.—Bear Island, Potomac River, Montgomery County, Md.

Types.—Holotype, male, U.S.N.M. no. 93439; paratypes, both sexes, U.S.N.M. no. 93440, and in writer's collection.

Remarks.—*Eulimnadia ventricosa* more closely resembles *E. stoningtonensis* Berry than any other North American species of the genus. *E. ventricosa* differs from *stoningtonensis* in the longer first antennae of the male; the greater number of telson spines, 14 being the maximum number in *stoningtonensis*; the origin of the forked filament of the telson between the third and fourth spines instead of between the fifth and sixth as in *stoningtonensis*; the more pronounced rostrum; a shell length-height ratio of 1.6 to 1 as against a 1.4 to 1 ratio for *stoningtonensis*; up to 12 growth lines in contrast to 10 for *stoningtonensis*; and a maximum size up to 10.7 mm, with 8.5 mm the longest shell length for *stoningtonensis*. Compared to other North American species *E. ventricosa* is larger, more ventricose, and has more lines of growth than any other member of the genus.

Eulimnadia ventricosa is represented in nine collections. This species was taken in seven collections from Bear Island, Md., by Robert S. Bray during July and September, 1941. Notes on the environment for these collections indicate that they were taken in small temporary pools with a recorded temperature variation of 71 to 88°F. and a pH variation of 6.4 to 6.7. In these collections there were 90 females and 9 males indicating a greater ratio of females than males as seems to be the case for other species of the genus.

The species is also represented in a collection of 16 females and 2 males taken at Lilypons, Frederick County, Md., by O. L. Meehean on July 12, 1937. Also, there was one female in a collection of *Cyzicus mexicanus* made by Eric Tuttle in a temporary pool between Chain Bridge and Georgetown, D. C., on July 18, 1950.

Eulimnadia francesae, n. sp.

Description.—Male: The bivalve shell (Fig. 1, *h*) is pale yellow, transparent, and very much elongate. The dorsal margin is nearly straight with only a slight elevation near the center of the shell. The ventral margin is regularly rounded. The shell length varies in mature males from 4.3 mm, with a height of 2.5 mm, to 4.5 by 2.7 mm. There are 1 or 2 lines of growth, with 2 the common number, located near the outer margin.

The head possesses the typical, dorsal pyriform frontal organ (Fig. 1, *j*). The front is very straight, only slightly concave. The scape of the second antennae is short, extending only slightly beyond the tip of the rostrum. The flagella of the second antennae are variously spined, 9 segmented, and are relatively short. The first antennae with 10 to 12 dorsal papillae extends to the distal end of the fifth segment of the second antennae flagella.

The body bears 18 pairs of swimming legs. The first and second pairs are modified gnathopods. The sixth endite of the first gnathopod is shorter than the length of the "claw" portion (Fig. 1, *l*). The two segments of the sixth endite of the second gnathopod are of equal length. (Fig. 1, *m*).

The telson is truncate in general form (Fig. 1, *n*). The dorsal ridges are armed with 9 to 11 spines. The dorsal forked filament arises between the second and third pairs of spines. The terminal telson claws are elongated; they extend posteriorly less than the length of the dorsal telson margin.

Female: The shell is elongately oval with the dorsal margin slightly elevated (Fig. 1, *i*). The ventral margin is regularly and prominently rounded with the greatest height near the center of the shell. The number of growth lines on mature individuals varies from 2 to 4 with the greater number possessing 3 lines.

The head of the female is very similar in form to that of the male (Fig. 1, *k*). The front is only slightly concave and the dorsal surface is very convex with the occipital notch very conspicuous.

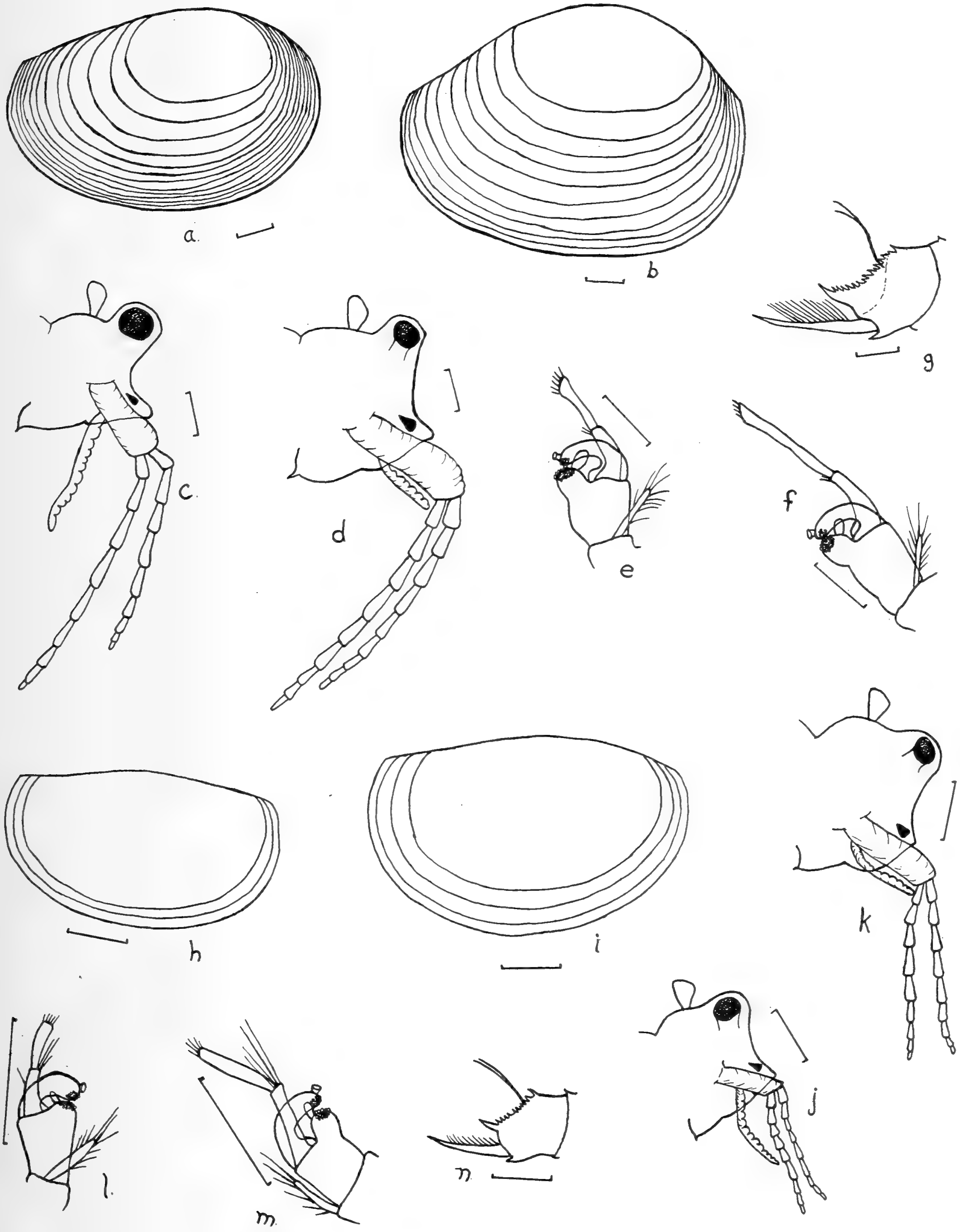

FIG. 1.—*a-g*, *Eulimnadia ventricosa*, n. sp.: *a*, Shell of male; *b*, shell of female; *c*, head of male; *d*, head of female; *e*, first gnathopod of male; *f*, second gnathopod of male; *g*, telson. *h-n*, *Eulimnadia francesae*, n. sp.: *h*, Shell of male; *i*, shell of female; *j*, head of male; *k*, head of female; *l*, first gnathopod of male; *m*, second gnathopod of male; *n*, telson. Scales: *a*, *b*, *h*, *i* equal 1 mm; all others 0.5 mm.

The second antennae have a longer scape than the male. The flagella of the second antennae are 9 segmented and are of equal length as in the male.

The 18 pairs of swimming legs are of the characteristic type of phyllopod swimming appendages.

The telson is similar to that of the male with 9 to 11 dorsal spines; 10 is the typical number.

Type locality.—Bear Island, Potomac River, Montgomery County, Md.

Types.—Holotype, male, U.S.N.M. no. 93446, paratypes, both sexes, U.S.N.M. no. 93447, and in the collection of the writer.

Remarks.—Eulimnadia francesae resembles *E. diversa* Mattox more than the other species in the genus. The distinctive differences between these two species are as follows: Shell of *E. francesae* is more elongate; the front of the head is more concave in *E. diversa*; the frontal organ is more dorsal in *E. francesae*; the occipital notch is more conspicuous, deeper, in *E. francesae*; in the relative length of the second antennae those of *E. francesae* are shorter than *E. diversa*; the first antennae of the male are longer in *E. francesae*; the equal length of the flagella of the second antennae is distinctive; *E. francesae* has a normal number of 10 telson spines while *E. diversa* has an average of 12; and the ventral telson claws of *E. francesae* are not as elongate as those of *E. diversa*. The elongate shell, the small size, and the small number of growth lines, make *E. francesae* different from all other North American species of the genus except *E. alineata* Mattox which has no lines of growth.

This species is represented in four collections all from Bear Island, Md., and collected by Robert S. Bray during July 1941. These animals were found in temporary pools with a recorded average temperature of 80°F. and a pH of 6.2. In the four collections there are 102 females and 17 males, again indicating the unequal ratio of the sexes typical of the genus.

REFERENCES

Berry, E. W. *Description and notes on the life history of a new species of* Eulimnadia. Amer. Journ. Sci. (5) **11:** 429–433. 1926.

Daday de Dees, E. *Monographie systematique des phyllopodes conchostraces*, Triseme Partie. Ann. Sci. Nat. Zool. (10) **11:** 1–81. 1926.

Mattox, N. T. *Studies of the life history of a new species of fairy shrimp*, Eulimnadia diversa. Trans. Amer. Micr. Soc. (2) **56:** 249–255. 1937.

Packard, A. S. *A monograph on the phyllopod Crustacea of North America.* 12th Ann. Rep. U. S. Geol. Surv. Terr., Hayden, **1:** 1883.

PROCEEDINGS OF THE ACADEMY

457TH MEETING OF BOARD OF MANAGERS

The 457th meeting of the Board of Managers, held for the first time in the Board Room of the new quarters of the Cosmos Club, 2121 Massachusetts Avenue, on October 13, 1952, was called to order at 8:07 p.m. by President Ramberg, with the following in attendance: Walter Ramberg, Frank M. Setzler, F. M. Defandorf, H. S. Rappleye, J. A. Stevenson, Harald A. Rehder, William F. Foshag, A. T. McPherson, Sara E. Branham, Roger G. Bates, A. G. McNish, John K. Taylor, C. A. Betts, A. H. Scott, L. A. Spindler, A. M. Griffin, N. R. Ellis, E. H. Walker, L. E. Yocum, and, by special invitation, F. N. Frenkiel.

The President announced that the November meeting would be addressed by John Hagen, of the Naval Research Laboratory, on *Radio astronomy*.

Archibald T. McPherson, chairman of the Committee on Encouragement of Science Talent, presented the following report:

Junior Academy.—The organization of the Washington Junior Academy of Sciences was consummated on June 13, 1952, at a meeting held in the Cosmos Club. Watson Davis, director of Science Service, addressed the meeting on *Science for Youth*. The Committee designated about 85 students and 40 recent graduates of secondary schools in the Greater Washington area as members and alumni members, respectively. The selection was based on tangible achievements such as the winning of recognition in science fairs, science talent searches, or related activities. The Committee also designated 57 fellows of the Junior Academy, including teachers whose students had shown outstanding accomplishments and others who have been especially active in the promotion of science education.

The affairs of the Junior Academy are in the hands of a Governing Council comprised of the following persons in addition to the Committee on the Encouragement of Science Talent:

Officers: Fred Schindler (President), Northwestern High School; Vernon J. Michel (Vice President), Kelly Miller Junior High; Stanley Platnik (Treasurer), Roosevelt High School; Mary Jeanne Kreek (Secretary), Woodrow Wilson High School.

Alumni Representatives: Carol Colson, Eastern High School; Lee Kimbell, McKinley High School–American University.

Fellow Representatives: Margaret E. Patterson, Science Clubs of America; Percy J. Rayford, head, Department of Science, Division 2; Keith C. Johnson, head, Department of Science, Division 1.

Membership Representatives: Daniel Mix, Macfarland Junior High School; Siegfried T. Balzer, Gonzaga High School; David W. Ray, Dunbar High School.

Science Service has kindly provided a meeting place for the Governing Council as well as office facilities.

The first meeting of the Junior Academy for the current season was held at the George Washington University on September 19 through the courtesy of Dr. Yocum, dean of the Graduate School. Howard Owens gave an illustrated lecture on *Selection of a Science Project*, after which the meeting divided into eight discussion groups each led by an outstanding scientist of the Washington area who gave further advice and guidance regarding the selection of projects in specific fields.

Cooperation with Engineers.—The D. C. Council of Engineering and Architectural Societies has a Committee on Education which has been assigned duties parallel to those of two Academy Committees—the Committee on Science Education headed by Dr. Brode, and the present Committee on Encouragement of Science Talent. Dr. W. T. Read, chairman of the Education Committee of the Council, is also a member of the Academy, Committee on Encouragement of Science Talent and provides liaison between the activities of the two organizations. An understanding has been arrived at whereby the Committee of the Council will direct its efforts at arranging speakers for school assemblies and conferences whereas the Academy Committee will take the lead in affairs of the Junior Academy and the Science Fair.

A subcommittee of the Academy Committee is being set up under the chairmanship of Dr. A. H. Scott to arrange for scientists to speak in schools along with engineers and to cooperate with a parallel subcommittee of the Engineers under the chairmanship of Mr. McCartha.

Science Fair.—An estimate of $1,000 has been made for the cost of the Science Fair to be held next spring. Letters have gone out to all the societies affiliated with the Academy asking them for contributions, and the President of the Academy has been asked personally to present the matter to the vice presidents representing the respective societies.

The D. C. Council, likewise, is asking for substantial contributions from its affiliated societies.

A discussion of this report brought out the following additional information: Eligibility for charter membership was based on (1) selection of members by science teachers whose activity in connection with the Science Fair and Science Talent Search projects was exceptionally good, (2) the selection of teachers to be designated as fellows based on the performance of their students judged on the same basis; certain other fellows were designated on the basis of their interest as evidenced by activity in this connection, (3) the selection as alumni members of a few graduates on the basis of their accomplishments as evidenced from these projects and the recommendation in addition of those teachers designated as fellows.

The annual membership dues are $1. The Junior Academy is solvent. So far nothing has been spent out of the $100 provided by the Washington Academy for initial organizational expenses of the Junior Academy. The academies of Maryland and Virginia have no objection to students in nearby schools becoming members of the Washington Junior Academy of Sciences. Treasurer Rappleye, who is ex-officio custodian of funds, will handle and report on the Junior Academy funds separately from those of the Washington Academy.

For the Committee on Science Education, A. T. McPherson reported that its chairman, W. R. Brode, had discussed with Judge Laws the matter of appointing a scientist as a member of the District of Columbia Board of Education. It appears that all appointments to the Board have been completed so that recommendations would be out of order at this time.

In accordance with action by the Board at its last meeting, ballots relative to changes in the constitution and bylaws to provide for sponsorship of the Washington Junior Academy of Sciences were forwarded to the Academy membership. Copies of the proposed constitution and bylaws for the Junior Academy and a brief summary of actions by the Board on this connection were attached.

Deaths of the following members were reported: E. C. Auchter, on July 8, 1952; Ida A. Bengston, on August 15, 1952; R. A. Kelser, on April 16, 1952; H. E. McComb, on October 11, 1952; A. E. McPherson, on August 5, 1952; P. F. Neményi, on March 1, 1952; and J. L. Peters on April 19, 1952.

On request, J. H. Service was placed on the retired list.

In view of a provision in the constitution and bylaws adopted by the Washington Junior Academy of Sciences the following was proposed and adopted as the 18th of the Standing Rules of the Board of Managers of the Washington Academy:

> *18.* The President shall designate each year a member of the Committee on the Encouragement of Science Talent to serve as Chairman of the Governing Council of the Washington Junior Academy of Sciences.

Senior Editor Foshag reported that the Journal now has a backlog of papers awaiting publication sufficient to fill six issues. His report was discussed by Messrs. McNish and Ramberg, and it was brought out that in so far as possible charges to authors are kept at a minimum and occur primarily when there are a large number of illustrations.

Because of an expressed interest in the Journal as a possible medium for more papers on physics, Dr. F. N. Frenkiel, of the Johns Hopkins Applied Physics Laboratory, had been invited to present his views at this meeting of the Board. He was asked to present his thoughts. Dr. Frenkiel stressed the following points:

1. Existing journals do not seem satisfactory for many general articles on physics as these journals individually cover only highly specialized fields. Thought is now being given to the establishment of additional journals.
2. It would not be a difficult matter to enlarge the Journal of the Academy and to publish a good many articles in physics and engineering. These articles in other magazines must be self-supporting.
3. One serious drawback to publication by physicists in the Journal arises from its limited circulation among physicists and libraries.
4. Another arises from the fact that the Academy, because it has no library, does not maintain exchange relations with other journals. Thus the Journal is not well known except in highly specialized fields.
5. Thus, it seems that a field of coverage in scientific applications of physics and engineering exists which, were the academy interested in expanding the size and distribution of its Journal might be more actively exploited.
6. This would entail an interested and well-qualified group of physicists who would contribute regularly and would assure initially several articles in each issue over, say a period of one year.
7. With this backlog as a basis for an announceable change in policy of content an attempt at increased circulation should succeed.
8. Other scientific and mathematical journals ask laboratories and firms to pay for the publication of articles by their staff members. Government laboratories might well give some such backing through assured purchase of reprints which they need.
9. Because Washington has a very large scientific population it should have a satisfactory local publication that would publish articles promptly.

The discussion was continued by Messrs. Foshag, McNish, McPherson, Ramberg, and Setzler. It was pointed out that: A, The Academy must be willing to have its present Journal grow in size and circulation; B, the price of the Journal might have to be increased; C, definite assurance of suitable articles would have to be determined and announced; E, individuals and libraries would have to be circulated and sent free sample copies. President Ramberg asked the Board of Editors to give this proposal its consideration.

Vice-President McNish reported that the Philosophical Society had held its first meeting in the New Auditorium of the Cosmos Club. The acoustics are good and a new projector has been ordered. The Philosophical Society would be willing to contribute toward a good moving picture projector if the other Affiliated Societies will participate. The vice-presidents were requested to ask their societies whether they could make substantial contributions toward such a projector.

President-Elect Setzler mentioned receipt of a request for assistance from the Joint Press Relations Committee that supplies the Science Calendar material regularly to four Washington papers, the Engineers' Club, three universities, and eight technical or governmental bulletin boards or papers. The budget amounts to $125.97 for the coming years. It was understood that the Treasurer will forward half this amount as a contribution of the Academy and its affiliated societies.

The meeting was adjourned at 9:45 p.m.

F. M. Defandorf, *Secretary.*

Obituaries

Paul Felix Neményi. The formal details of Neményi's life are as follows: Born June 5, 1895, in Fiume; Dipl. Ing. Budapest Inst. Tech. 1918; Dr. Ing. Berlin Inst. Tech. 1922; Habilitation; died March 1, 1952, in Washington, D. C.

Neményi's life-long interest was pure mechanics. He worked mainly in five fields: static elasticity, fluid dynamics, hydrology and hydraulics, organization of mechanics, methods of research.

The first of his three major discoveries in elasticity was a new singularity method [Zeitschr. Angew. Math. Mech. **9:** 488 (1929); **10:** 383 (1930)]. A number of rather complicated singularities, obtained by confluence of simple ones, are classified in terms of their influences in accordance with a duality principle. Neményi's statement of this generalization of Maxwell's reciprocity theorem is: "The influence lines, influence surfaces (or in general the influence fields) of any influence in the elastic solid, can be represented by deflection curves, deflection surfaces (or in general by the displacement field) of the same solid, if acted upon by a singularity *dually corresponding* to the influence in question." Possibly this principle, which has not attracted the attention it deserves and has never been put into mathematical form, could be made the basis of a general integration procedure. Neményi was content to illustrate its usefulness in special problems concerning beams, plates, and slabs.

His interest in analogies, which he collected and always planned to organize into a treatise on the method, may well have begun with his own discovery that the stream-lines of any potential flow of an incompressible fluid may serve also as stress trajectories for a plane elastic system. He first approached the problem through his method of singularities [Proc. Int. Congr. Applied Mech. 1930]; later [Zeitschr. Angew. Math. Mech. **12:** 364 (1931)], he gave an analytic proof of this beautiful result in the reformulation now called "Neményi's Theorem": *Given any net of isothermal curves, there exists a five parameter family of plane stress systems for which these curves are stress trajectories.* Phrased thus in terms of pure elasticity, it suggests another question: To what extent is the solution of a problem in continuum mechanics characterized by an associated trajectory system? This subject attracted Neményi throughout the rest of his life. For a certain class of problems in plane plasticity, it was answered in a paper written with Van Tuyl [Quart. Journ. Math. Mech. **5:** 1 (1952)]; a more general elastic case is considered in a paper written with Sáenz [Journ. Rat. Mech. Anal. **1,** 73 (1952)]; and related problems were solved by Prim and Sáenz.

His third major discovery in elasticity is the reduction of the general extensional theory of thin shells of revolution with meridian $y = f(x)$ to the remarkably simple equation

$$\frac{U_n''}{U_n} + (n^2 - 1)\frac{f''}{f} = 0.$$

The functions U_n, called "Neményi's stress functions," yield at once the nth Fourier coefficients of all stress resultants. This fact has been made the basis of an analytic theory for this class of shell problems, and to the equation itself, which should be called "Neményi's equation," some subsequent literature has been devoted. Neményi discovered the result by an intricate analysis in graphical statics [Bygningsstatiske Meddelelser (1936), abstr. in Proc. 6th Int. Congr. Math. (1936)]; later an analytical derivation was obtained [Proc. Nat. Acad. Sci. **29:** 159–162 (1943)].

All this theoretical work illustrates the inverse or semi-inverse approach, of which Neményi was a strong advocate. He summarized the field in a fine organizational summary [Adv. Applied Mech. **2,** 123–151 (1951)]. While this paper does not contain any original contribution, the viewpoint expressed is sound, and the special cases presented are strong advocates for the value of the method. The paper itself is significant as a counter to the current flood of blinding calculation of "approximate" solutions; it deserves careful reading and reflection from every serious student of mechanics. In papers written jointly with Prim [Proc. Nat. Acad. Sci. **34:** 119 (1948); Journ. Math. Phys. **27:** 130 (1948); Proc. 7th Int. Congr. Appl. Mech. **2:** 300; Quart. Journ. Math. Mech. **2:** 129 (1949)] he applied inverse and semi-inverse methods to obtain numerous exact solutions of the nonlinear equations of gas dynamics, many of them representing rotational flows of nonuniform total energy. He named and pointed out the importance of "generalized Beltrami flows," in which the reduced velocity is a Beltrami field, and obtained many examples. The impressive variety of results to which his viewpoint, complemented by proper analytical apparatus, has ultimately led may be seen in the Princeton thesis of Prim [Journ. Rat. Mech. Anal. **1:** 425–497 (1952)].

Neményi's scientific knowledge extended well beyond the subjects of his researches, and the organization and scope of his numerous expository articles give them permanent value; e.g., "Selbstspannungen elastischer Gebilde" [Zeitschr. Ang. Math. Mech. **11:** 59 (1931)], "Tragwerke auf elastisch nachgiebiger Unterlage" [ibid.; 450]. He was a leading authority on fishways [Iowa Studies in Eng., Nos. 23 and 24 (1941)] and the morphology of rivers [forthcoming review in Trans. Amer. Geogr. Union]. His "Wasserbauliche Strömungslehre" [Leipzig, 1933] was the first book to include an exposition of fluid flow through porous media. Other surveys deal with water power, soil mechanics, theory of structures, transport of granular materials, and filtration. He left a draft for an extraordinary book on fluid mechanics, emphasizing the basic principles valid for all types of fluids and the consequent variety of their application to aerodynamics, hydraulics, meteorology, oceanography, and other fields. The introductory chapter is an analysis of the historical development of the main ideas and concepts, both in theory and in experiment, drawn entirely from the original sources. It will be completed and published as a memoir.

Experimental work always interested him, and by inserting into a stream a lens-shaped rotatable tube, punctured by a single hole and connected to a manometer, he was able to make rapid measurements of velocity direction along with speed and pressure [*A new device for direct stream field studies*, Copenhagen, 1935].

Neményi's interest and ability extended to several nonscientific fields. He collected children's art and sometimes lectured upon it. One of his last works is a brilliant review of the Encyclopedia Brittanica [New Republic, Feb. 19, 1951].

For any person with a genuine question in mechanics, Neményi was always willing to supplement his great knowledge and deep understanding by hours of library work. Since 1946 many of his ideas were worked out by his pupils: (in temporal order) C. Truesdell, R. C. Prim, A. Van Tuyl, A. W. Sáenz, R. Toupin, J. L. Ericksen.

After a life of travel and change, during which he held minor positions in institutions in several foreign countries, Neményi came to the United States in 1939. Unfortunately here he found the problem of livelihood aggravated by the rifts between pure and applied mathematics, between pure science and engineering, between classical and modern physics, between teaching and research. For a no longer young person, whose English was poor, whose dress was unconventional, whose training was in civil engineering, and who claimed to be a physicist doing research on the principles of continuum mechanics, the mere gaining of daily bread became a major obstacle. With one exception, it was only in college mathematics departments that he was able to find employment at all, and here it came as a blow to him that a lifelong student of educational methods and one moreover especially attracted by youth could turn out to be utterly incapable of dealing with undergraduate students, whose sole concern was to get a passing grade at the cost of as little learning as possible. The fact that most of his publications date from before 1933 or after 1946 is thus easily explained, since it was in the latter year that he joined the Naval Ordnance Laboratory, where he became a guiding spirit in the Theoretical Mechanics Subdivision during its brief period of scientific productivity in 1946–1948. In 1949 he became a member of the Academy. In 1949 he transferred to the Naval Research Laboratory, where he later became Head of the Theoretical Mechanics Section, a position he held at his death.

He leaves a son, Peter, student of mathematics at Princeton University.

C. Truesdell.

Edwin F. Wendt was born May 12, 1869, in New Brighton, Pa., a son of Christian and Agnes Scott Wendt. He was a grandson of John Scott, associate judge of Beaver County (Pa.), a great grandson of Frederick Wendt, pioneer glass manufacturer of Pittsburgh, and a great grandson of David Scott, quartermaster of the army of General Anthony Wayne.

He graduated from Geneva College in 1888 and was awarded the degree of doctor of science in 1913. He entered the employ of the Pittsburgh & Lake Erie Railroad in 1888 as a roadman, eventually becoming assistant chief engineer. He later became engineer in charge of construction for the Lake Erie & Eastern Railroad. He was a member of the New York Central Lines engineering committee from 1907 to 1913.

Dr. Wendt was a member of the government commission which inspected the Alaska Railroad in 1917. He was also a member of the Engineering Board of the Interstate Commerce Commission, and chief inspector in charge of the Eastern Division of the Bureau of Valuation of the I.C.C. from 1913 to 1921. He then left government service to enter private consulting practice, and was admitted to practice before the Interstate Commerce Commission in 1929.

In addition to membership in the Washington Academy of Sciences, he was a member of the American Society of Civil Engineers, the American Institute of Consulting Engineers (president 1936–37), Engineers Society of Western Pennsylvania, Washington Society of Engineers (president 1918), American Association for the Advancement of Science, Signal Section of American Association of Railroads, American Economic Association, Historical Society of Western Pennsylvania, and the Railway Club of Pittsburgh. He was also a trustee of Geneva College for ten years.

attention it deserves and has never been put into mathematical form, could be made the basis of a general integration procedure. Neményi was content to illustrate its usefulness in special problems concerning beams, plates, and slabs.

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His third major discovery in elasticity is the reduction of the general extensional theory of thin shells of revolution with meridian $y = f(x)$ to the remarkably simple equation

$$\frac{U_n''}{U_n} + (n^2 - 1)\frac{f''}{f} = 0.$$

The functions U_n, called "Neményi's stress functions," yield at once the nth Fourier coefficients of all stress resultants. This fact has been made the basis of an analytic theory for this class of shell problems, and to the equation itself, which should be called "Neményi's equation," some subsequent literature has been devoted. Neményi discovered the result by an intricate analysis in graphical statics [Bygningsstatiske Meddelelser (1936), abstr. in Proc. 6th Int. Congr. Math. (1936)]; later an analytical derivation was obtained [Proc. Nat. Acad. Sci. **29:** 159–162 (1943)].

All this theoretical work illustrates the inverse or semi-inverse approach, of which Neményi was a strong advocate. He summarized the field in a fine organizational summary [Adv. Applied Mech. **2,** 123–151 (1951)]. While this paper does not contain any original contribution, the viewpoint expressed is sound, and the special cases presented are strong advocates for the value of the method. The paper itself is significant as a counter to the current flood of blinding calculation of "approximate" solutions; it deserves careful reading and reflection from every serious student of mechanics. In papers written jointly with Prim [Proc. Nat. Acad. Sci. **34:** 119 (1948); Journ. Math. Phys. **27:** 130 (1948); Proc. 7th Int. Congr. Appl. Mech. **2:** 300; Quart. Journ. Math. Mech. **2:** 129 (1949)] he applied inverse and semi-inverse methods to obtain numerous exact solutions of the nonlinear equations of gas dynamics, many of them representing rotational flows of nonuniform total energy. He named and pointed out the importance of "generalized Beltrami flows," in which the reduced velocity is a Beltrami field, and obtained many examples. The impressive variety of results to which his viewpoint, complemented by proper analytical apparatus, has ultimately led may be seen in the Princeton thesis of Prim [Journ. Rat. Mech. Anal. **1:** 425–497 (1952)].

Neményi's scientific knowledge extended well beyond the subjects of his researches, and the organization and scope of his numerous expository articles give them permanent value; e.g., "Selbstspannungen elastischer Gebilde" [Zeitschr. Ang. Math. Mech. **11:** 59 (1931)], "Tragwerke auf elastisch nachgiebiger Unterlage" [ibid.; 450]. He was a leading authority on fishways [Iowa Studies in Eng., Nos. 23 and 24 (1941)] and the morphology of rivers [forthcoming review in Trans. Amer. Geogr. Union]. His "Wasserbauliche Strömungslehre" [Leipzig, 1933] was the first book to include an exposition of fluid flow through porous media. Other surveys deal with water power, soil mechanics, theory of structures, transport of granular materials, and filtration. He left a draft for an extraordinary book on fluid mechanics, emphasizing the basic principles valid for all types of fluids and the consequent variety of their application to aerodynamics, hydraulics, meteorology, oceanography, and other fields. The introductory chapter is an analysis of the historical development of the main ideas and concepts, both in theory and in experiment, drawn entirely from the original sources. It will be completed and published as a memoir.

Experimental work always interested him, and by inserting into a stream a lens-shaped rotatable tube, punctured by a single hole and connected to a manometer, he was able to make rapid measurements of velocity direction along with speed and pressure [*A new device for direct stream field studies*, Copenhagen, 1935].

Neményi's interest and ability extended to several nonscientific fields. He collected children's art and sometimes lectured upon it. One of his last works is a brilliant review of the Encyclopedia Brittanica [New Republic, Feb. 19, 1951].

For any person with a genuine question in mechanics, Neményi was always willing to supplement his great knowledge and deep understanding by hours of library work. Since 1946 many of his ideas were worked out by his pupils: (in temporal order) C. Truesdell, R. C. Prim, A. Van Tuyl, A. W. Sáenz, R. Toupin, J. L. Ericksen.

After a life of travel and change, during which he held minor positions in institutions in several foreign countries, Neményi came to the United States in 1939. Unfortunately here he found the problem of livelihood aggravated by the rifts between pure and applied mathematics, between pure science and engineering, between classical and modern physics, between teaching and research. For a no longer young person, whose English was poor, whose dress was unconventional, whose training was in civil engineering, and who claimed to be a physicist doing research on the principles of continuum mechanics, the mere gaining of daily bread became a major obstacle. With one exception, it was only in college mathematics departments that he was able to find employment at all, and here it came as a blow to him that a lifelong student of educational methods and one moreover especially attracted by youth could turn out to be utterly incapable of dealing with undergraduate students, whose sole concern was to get a passing grade at the cost of as little learning as possible. The fact that most of his publications date from before 1933 or after 1946 is thus easily explained, since it was in the latter year that he joined the Naval Ordnance Laboratory, where he became a guiding spirit in the Theoretical Mechanics Subdivision during its brief period of scientific productivity in 1946–1948. In 1949 he became a member of the Academy. In 1949 he transferred to the Naval Research Laboratory, where he later became Head of the Theoretical Mechanics Section, a position he held at his death.

He leaves a son, Peter, student of mathematics at Princeton University.

C. TRUESDELL.

EDWIN F. WENDT was born May 12, 1869, in New Brighton, Pa., a son of Christian and Agnes Scott Wendt. He was a grandson of John Scott, associate judge of Beaver County (Pa.), a great grandson of Frederick Wendt, pioneer glass manufacturer of Pittsburgh, and a great grandson of David Scott, quartermaster of the army of General Anthony Wayne.

He graduated from Geneva College in 1888 and was awarded the degree of doctor of science in 1913. He entered the employ of the Pittsburgh & Lake Erie Railroad in 1888 as a roadman, eventually becoming assistant chief engineer. He later became engineer in charge of construction for the Lake Erie & Eastern Railroad. He was a member of the New York Central Lines engineering committee from 1907 to 1913.

Dr. Wendt was a member of the government commission which inspected the Alaska Railroad in 1917. He was also a member of the Engineering Board of the Interstate Commerce Commission, and chief inspector in charge of the Eastern Division of the Bureau of Valuation of the I.C.C. from 1913 to 1921. He then left government service to enter private consulting practice, and was admitted to practice before the Interstate Commerce Commission in 1929.

In addition to membership in the Washington Academy of Sciences, he was a member of the American Society of Civil Engineers, the American Institute of Consulting Engineers (president 1936–37), Engineers Society of Western Pennsylvania, Washington Society of Engineers (president 1918), American Association for the Advancement of Science, Signal Section of American Association of Railroads, American Economic Association, Historical Society of Western Pennsylvania, and the Railway Club of Pittsburgh. He was also a trustee of Geneva College for ten years.

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JOURNAL
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PALEONTOLOGY.—Jedria, *a new subgenus of* Naticopsis[1]. ELLIS L. YOCHELSON, U. S. Geological Survey. (Communicated by G. Arthur Cooper.)

While I was working with Dr. J. Brookes Knight and others on the Paleozoic Gastropoda section of the *Treatise on invertebrate paleontology*, it became evident that clarification of the generic conception of *Naticopsis*, together with the proposal of one new subgenus, would be desirable before publication of the treatise. The following discussion is intended to provide the needed clarification:

Naticopsis (Jedria) Yochelson, n. subg.

Genotype: *Naticopsis meeki* Knight, 1933 (p. 373).

Neritiform shells with subsutural shoulders at ephebic stage. Neanic stages moderately high spired, having evenly rounded, unornamented whorls; mature whorl profile showing a subsutural shoulder followed by a very gently concave slope to a ventricose swelling at the periphery; shoulders of some species ornamented with strong transverse lirae.

In 1933, Knight (p. 363) informally proposed the group of *Naticopsis ventrica* (Norwood and Pratten), which included that species, the genotype species of *Jedria*, and *Naticopsis scintilla* Girty. Among European species, the subgenus appears to include *Naticopsis placida* (Koninck) and *N. plicistria* (Phillips) from the Lower Carboniferous, and *N. subcostata* (Archiac and Verneuil) from the Middle Devonian. One specimen, figured by Kittl as *Naticopsis* (*Hologyra*) *declivis* (1894, pl. 4, fig. 14), from the Triassic of Austria, is doubtfully referred to this subgenus.

The genus *Naticopsis* as recognized in the Paleozoic includes those gastropods with anomphalous shells that have straight, obliquely backward outer lips. A parietal inductura more or less extended in the plane of the aperture is always present. Ontogenetic changes in species are so extreme that juveniles cannot be identified with adults except on the basis of growth series. The genus considered broadly includes species of various shapes. Although these intergrade they appear to group themselves around several major types which here are considered subgenera. At least four of these are recognized.

Naticopsis (*Jedria*) as proposed above contains those relatively high spired shells that develop a subsutural whorl shoulder at maturity. *Naticopsis* (*Planospirina*) Kittl (1899, p. 48) includes relatively low spired shells that have smoothly rounded whorls, but with the final whorl turning obliquely downward. *Naticopsis* (*Naticopsis*) McCoy (1844, p. 33) is restricted to those species of *Naticopsis* that have moderately low spired shells with a mammary apex above a smoothly rounded profile. *Naticopsis* (*Marmolatella*) Kittl (1894, p. 142) includes low spired shells having the upper whorl surface flat and extending outward. The subgenera *Planospirina* and *Marmolatella* both have Triassic genotypes and have not been used commonly in the literature on Paleozoic Neritacea. *Fedaiella* Kittl (1894, p. 139), another name based on a Triassic genotype, seems to be a synonym of *Naticopsis* s.s.

REFERENCES

KITTL, E. *Die triadischen Gastropoden der Marmolata und verwandter Fundstellen in den weissen Riffkalken Südtirols.* Jahrb. K.K. geol. Reichenstalt **34**: 99–182, pls. 1–6. 1894.

———. *Die Gastropoden der Esinokalke nebst einer Revision der Gastropoden der Marmolatakalke.* Ann. K.K. naturh. Hofmuseums **14**: 1–237, pls. 4–6. 1899.

KNIGHT, J. B. *The gastropods of the St. Louis, Missouri, Pennsylvanian outlier: VI. The Neritidae.* Journ. Pal. **7**: (4): 359–392, pls. 40–46. 1933.

MCCOY, F. *A synopsis of the characters of the Carboniferous limestone fossils of Ireland*, pp. 5–207, pls. 1–29. Dublin, 1844.

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[1] Publication authorized by the Director, U. S. Geological Survey.

PALEONTOLOGY. Cardiniferella, *n. gen., the type of a new family of Carboniferous Ostracoda.* I. G. SOHN,[1] U. S. Geological Survey. (Communicated by J. S. Williams.)

The upper part of the Helms formation of western Texas contains an abundant ostracode fauna both in the limestones and in the interbedded shales (Sohn, 1950). These faunules, according to present-day knowledge, closely resemble the Chester ostracodes described by Cooper (1941) from Illinois. The new genus described here is restricted to the limestone beds, where it is relatively abundant as silicified specimens in insoluble residues resulting from digestion with hydrochloric acid. It has a "kirkbyan pit," a character that would place this genus in the family Kirkbyidae, were it not lacking the marginal rims that characterize genera in this family. The hingement in *Cardiniferella* is hitherto unrecorded in the Ostracoda.

Two recently published papers emphasize the variation and consequently the importance of hingement in the classification of fossil ostracodes. Levinson (1950) analyzes the hingements of several Paleozoic genera. He illustrates the hinge elements of *Ulrichia bituberculata* (McCoy) (p. 70, figs. 8a, b); this species is probably not a true *Ulrichia*, but it illustrates the hinge elements of some Kirkbyidae. Triebel (1950) analyzes the hingement of several post-Paleozoic genera, and defines (p. 313) the following types of hingement:

> *Merodont*, only one valve dentate.
> *Amphidont*, both valves with one or more hinge teeth.

Because *Basslerella* Kellett, 1935, from rocks of late Paleozoic age, has a merodont dentition Triebel assumes (pp. 313–314) that amphidont dentition developed from merodont. The relatively advanced amphidont hingement described in this paper does not shed any light on this assumption, because Triebel deals with genera in the family Cytheridae (suborder Podocopa). This paper deals with a new family that is in the same higher group as the Kirkbyidae, which probably belongs to a different suborder. It is premature to speculate regarding the phylogenetic relationship and evolution of the different types of dentition found in Ostracoda because the dentition of many Paleozoic genera has not as yet been worked out and because there are all too many undescribed genera that probably contain important clues to the development of the Ostracoda.

The writer is grateful to Arthur L. Bowsher, U. S. Geological Survey, for making available the insoluble residues of his collections from the Helms formation of Texas, in which the new genus occurs, and to Dr. C. C. Branson, University of Oklahoma, Norman, Okla., who collected additional material at the type locality.

CARDINIFERELLIDAE Sohn, n. fam.

Straight-backed reticulated marine ostracodes with "kirkbyan pit" and amphidont hinge.

This family differs from Kirkbyidae in hingement and in the absence of marginal ridges. *Tomiella* Spizharsky (1937, pp. 143–146, 166) differs from the Kirkbyidae in not having marginal ridges, but it does not belong in the Cardiniferellidae because of its simple hinge.

Cardiniferella Sohn, n. gen.

Type species: *C. bowsheri*, n. sp.

Subovate, straight-hinged ostracodes, lateral surface reticulate, except for smooth marginal area. Hinge incised, amphidont. Overlap slight, marginal area of one valve grooved to receive smaller valve. Muscle scar pit subcentrally located.

This genus differs from all previously described genera in hingement. *Amphissites* has a somewhat similar hingement in that the larger valve overlaps the accommodation groove at the ends and fits into terminal sockets that open to the outside, but the grooved or smaller valve does not have terminal teeth, thus resulting in a merodont hingement. The same features distinguish the cardiniferelloid hinge from the sansabelloid (Kloedenellidae) hinge, and from the hinges of several late Paleozoic genera placed in Leperditellidae.

Cardiniferella bowsheri Sohn, n. sp.

Figs. 1–12

Subovate in lateral view; dorsal and ventral

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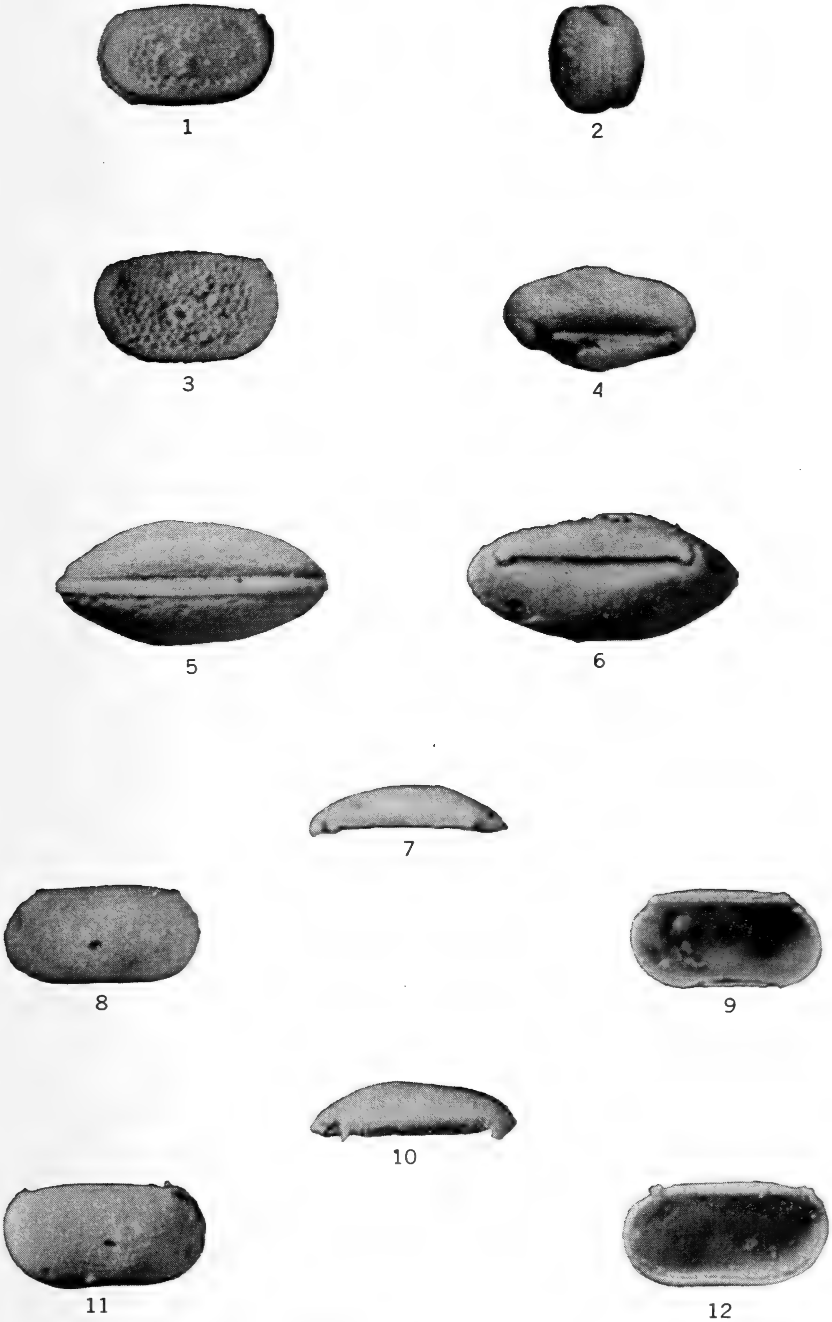
[1] Publication authorized by the Director, U. S. Geological Survey.



Figs. 1–12.—*Cardiniferella bowsheri* Sohn, n. gen., n. sp.: 1, 2, Left and anterior views of paratype U.S.N.M. 118306 from U.S.N.M. loc. 3069-2 (note smooth area where reticulations were abraided, and anterior tooth of right valve); 3, 4, right and dorsal views of holotype, U.S.N.M. 118307 from U.S.G.S. loc. 10889 (3, because the specimen is tilted backward, the pit appears on the photograph to be farther towards the posterior than it actually is; 4 is oriented with anterior to the left); 5, 6, ventral and dorsal views of a smooth specimen, paratype U.S.N.M. 118308 from U.S.N.M. loc. 3070-2 (5 is oriented with anterior to left, 6 with anterior to right); 7–12, dorsal, lateral, and interior views of opposing valves of a carapace that was opened for the purpose of illustrating the hingement (7–9, left valve, 10–12, right valve, paratype U.S.N.M. 118309 from U.S.N.M. loc. 3070-2; note reflection of muscle scar pit on inside of Fig. 12; the anterior cardinal portion of fig. 10 is broken). (Magnification approx. ×30)

margins straight, subparallel. End margins curved, greatest curvature of anterior margin lower than that of posterior. Lateral surface reticulated, marginal areas and dorsum nonreticulated. Oval "kirkbyan pit" located anterior to midlength and slightly below midheight. Hingement incised, amphidont, consists of an accommodation groove in the smaller valve terminated by rounded, tenonlike teeth that are bounded by sockets that open to the outside. The dorsal edge of the overlapping valve terminated by accommodating mortiselike sockets that are open dorsally; these are flanked by terminal teeth that consist of an enlargement of the overlapping portion of the larger valve. The overlapping valve has a groove along the marginal area to receive the bevelled edge of the smaller valve. This grooved zone is offset from the valve surface, resulting in a rimlike pleat on the outside of the valve. The smaller valve has a narrow bevelled edge bordered by a thin strip that seals the closing valves. A very narrow duplicature is suggested in many specimens by a thin zone that borders the inside of the overlapping structures of both valves. Dorsal and ventral outlines subovate, greatest convexity just in front of muscle scar pit.

Cyathus vetustus Cooper, 1941, resembles this species in outline; it differs in the hingement and in the absence of a subcentral muscle scar pit, and it is devoid of reticulations.

The preservation of many of the specimens does not show the reticulation (Figs. 5–12), but the presence of specimens with patches of the reticulations abraded (Fig. 1) indicates that the smooth forms having the characteristic outlines and hingement are conspecific with the reticulated forms.

Measurements	*Greatest length (mm)*
Holotype, Figs. 3, 4, U.S.N.M. 118307	0.81
Paratype, Figs. 1, 2, U.S.N.M. 118306	0.86
Paratype, Figs. 5, 6, U.S.N.M. 118308	1.27
Paratype, Fig. 8, U.S.N.M. 118309	0.93
Paratype, Fig. 11, U.S.N.M. 118309	0.98

Type locality.—U.S.G.S. 10889 Helms formation, El Paso quadrangle, Tex., 2½ miles west of Powwow Tanks, approximately 30° 50′ 17″ N., 106° 04′ 40″ W. Stop 13, West Texas Geol. Soc. Guidebook, Field Trip 5, 1949, and limestone bed 9, sec. "C" West Texas Geol. Soc. Field Trip May–June 1946 (stop 1 on map accompanying that trip). Coll. C. C. Branson, November 1949, A. L. Bowsher, 1948 (U.S.N.M. locality 3070-2).

Distribution.—This species is abundant also in bed 11 of the same section (U.S.N.M. locality 3070-4), and at approximately the same stratigraphic level in a saddle 1.1 miles west of Powwow Tanks, approximately 31° 50′ 16″ N., 106° 02′ 55″ W. (U.S.N.M. locality 3069-2).

REFERENCES

COOPER, C. L. *Chester ostracodes of Illinois.* Illinois Geol. Surv. Rep. Investigations No. 77: 101 pp., 13 pls. 1941.

LEVINSON, S. A. *The hingement of Paleozoic Ostracoda and its bearing on orientation.* Journ. Pal. **24**: 63–75, 16 figs. 1950.

SOHN, I. G., *Comparison of etched silicified ostracodes from limestone with calcareous forms from subjacent shale.* Bull. Geol. Soc. Amer. **61** (12): pt. 2, 1504 (abs.). 1950.

SPIZHARSKY, T. N. *Ostracoda from the Kolchugino series of the coal-bearing strata of the Kuznetsk Basin.* Trans. Central Geol. and Prosp. Inst., fasc. **97**: 139–171 (Russ., Engl. Summ.), 2 figs., 1 pl. 1937.

TRIEBEL, ERICH. *Homöomorphe Ostracoden-Gattungen.* Senckenbergiana **31**: 313–330. 1950.

BOTANY.—*Some new combinations in Guatemalan Bromeliaceae.* LYMAN B. SMITH, Department of Botany, U. S. National Museum.

The following new combinations are necessary preliminary to the publication of the Bromeliaceae in a projected part of the Flora of Guatemala by Standley and Steyermark.

Tillandsia elongata H. B. K. var. **subimbricata** (Baker) L. B. Smith, comb. nov.

Tillandsia subimbricata Baker, Journ. Bot. **25**: 304. 1887.

In 1889 André (Brom. Andr. 96) indicated that he did not consider *Tillandsia subimbricata* specifically distinct from *T. elongata,* although he failed to make any combination for it. Subsequent collections have shown a series of intergradations that amply justify André's opinion.

Tillandsia tricolor Schlecht. & Cham. var. **melanocrater** (L. B. Smith) L. B. Smith, comb. nov.

Tillandsia melanopus E. Morr. ex Mez. in DC. Monogr. Phan. **9**: 680. 1896, in large part but not as to type.

Tillandsia melanocrater L. B. Smith, Contr. Gray Herb. **117**: 31. 1937.

When first proposed on the basis of a few collections this taxon seemed easily distinguishable from *Tillandsia tricolor*. However, recent collections from Guatemala break down all distinctions except the highly artificial one of size. It seems best, therefore, to regard *T. melanopus* as a Central American variety of the Mexican *T. tricolor*.

Vriesia montana (L. B. Smith) L. B. Smith & Pittendrigh, comb. nov.
Thecophyllum montanum L. B. Smith in Yuncker, Field Mus. Publ. Bot. **17**: 319. 1938.

The validity of the genus *Thecophyllum* will be discussed in detail in a later paper by Dr. C. S. Pittendrigh and myself, but the above combination must be made now.

ENTOMOLOGY.—*Studies in Panama* Culicoides (*Diptera: Heleidae*): I, *Descriptions of six new species*.[1] WILLIS W. WIRTH[2] and FRANKLIN S. BLANTON.[3] (Communicated by Curtis W. Sabrosky.)

This paper is the first of a short series to bring up to date our taxonomic knowledge of the Panama species of biting midges of the genus *Culicoides* Latreille. In 1951 the junior author began a comprehensive survey of the biting Diptera of Panama. It soon became apparent that the large numbers of both male and female *Culicoides* which were collected in the traps in use for this survey would afford an unexcelled opportunity for a taxonomic study. The senior author, with a great taxonomic interest in the Heleidae, and advantageously located at the U. S. National Museum, where the types of a number of Neotropical species of *Culicoides* are located, was therefore invited to join in a cooperative study.

Our efforts were greatly stimulated by the recent appearance of several important papers on the Caribbean biting midges of this genus, including papers by Barbosa (1947), Fox (1946, 1947), Macfie (1948), and Ortiz (1950, 1951). All these authors have presented keys for the identification of the Caribbean species. With the great amount of descriptive work concurrently going on, however, keys are out of date almost as soon as published. Nevertheless, they are invaluable as working tools, and in a later paper of this series we will present a key to the Panama species.

Our terminology is the same as that employed by Wirth (1952), where a more complete description of terms can be found. The most important difference between our usage and that of some other *Culicoides* workers is in our designation of the wing veins and corresponding cells according to Tillyard's modification of the Comstock-Needham system; thus veins Cu_1 and Cu_2 of older workers become M_{3+4} and Cu_1, respectively, and cell Cu_1 becomes cell M_4 (labeled in Fig. 2). Length is measured in relaxed specimens from the anterior edge of the mesonotum to the tip of the abdomen; a more reliable measurement is the wing length, which along with the costal ratio is measured from the basal arculus. Body measurements, antennal and palpal proportions, and descriptions of male genitalia are obtained from specimens cleared in pure phenol and mounted on slides in phenol-balsam mixture after gradual infiltration. By this method dried specimens can be relaxed and cleared, and the refractive index of the phenol-balsam brings out the minute details of the antennal and palpal sensoria, the female spermathecae, and the internal structures of the male genitalia. In the following descriptions no special mention is made of the rudimentary third spermatheca and sclerotized ring of the female internal reproductive organs, as they are present in all Neotropical species that we have studied.

To our knowledge Ortiz (1951) was the first to show the presence of the dense tufts of short, curved setae around the margins of disciform, hyaline sensoria at the apices of certain antennal segments. We have made a comparative study of them in our species with very promising results. These tufts are always present on the third (first flagellar)

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[1] Published under the auspices of the Surgeon General, U. S. Army, who does not necessarily assume responsibility for the professional opinions expressed by the authors.

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segment, occasionally on segments 4– or 6–7, nearly always on 8, 9, and 10, but only rarely on the five distal segments except in the species with the second anterior radial cell in a light area, where they appear on some or all of these segments.

The types of our new species are deposited in the collection of the U. S. National Museum in Washington. Unless otherwise indicated, all specimens were collected by the junior author in light traps. We wish especially to acknowledge the generous assistance of Irving Fox, John Lane, and Ignacio Ortiz-Cordero in making comparisons of species or furnishing valuable opinions on certain species, and for supplying specimens for comparative study. P. A. Woke and L. E. Rozeboom furnished Panama material for study, including some specimens from series which in part formed the type series of new species described by Fox (1947) and Barbosa (1947). We also gratefully acknowledge the assistance rendered by Col. Francis P. Kintz, Surgeon, and Lt. Col. Edward J. Dehne, Chief of Preventive Medicine, United States Army Caribbean, as well as personnel of the 25th Preventive Medicine Survey Detachment.

Culicoides uniradialis Wirth and Blanton, n. sp.
Fig. 1, *a–d*

♀. Length 1.1 mm, wing 1.1 mm by 0.4 mm. Head pruinose dark grayish brown; eyes broadly separated, bare. Antennae with flagellar segments in proportion of 25:22:22:22:20:20:20:20:20:20:20:20:30, all except apices of segments 3–10 pale, remainder dark; distal sensory tufts on segments 3, 8, 9, 10. Palpal segments (Fig. 1, *b*) in proportion of 10:20:27:10:10, third segment very slightly swollen, with a small shallow sensory pit.

Mesonotum rather narrow, color uniform light tawny brown, with numerous short, appressed, yellowish hairs; scutellum concolorous with mesonotum. Postscutellum dark pruinose brown, pleura pale with transverse median area darker. Legs brown, subapical rings on femora, bases and apices of mid and hind tibiae, and distal tarsal segments on all legs, pale.

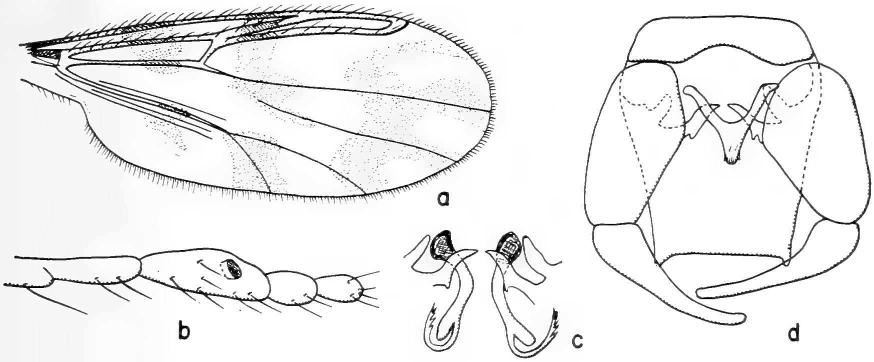
Wing (Fig. 1, *a*) with anterior radial cells not separated, the single cell long and narrow; costa to 0.75–0.8 of wing length; macrotrichia entirely absent. Wing predominantly pale yellowish, with faint, grayish, irregular bands: anterior radial cell pale except where covered by second dark wing band from a fourth of the way to halfway to apex. First dark wing band at proximal fourth of wing from costa to anterior media, interrupted and appearing again on base of vein M_{3+4} + Cu. Second band across second fourth of anterior radial cell taking in base of medial fork, interrupted and appearing again across basal half of mediocubital fork. Third band beginning as an oblique, dark mark across middle of cell R_5 from wing margin near apex of cell, broadening toward vein M_1 and extending along this vein and forming a broad dark mark in front of its apex; continuing broadly across middle of cells M_1 and M_2 to apex of vein M_{3+4} and following vein M_2 also to apex. Halteres pale.

Abdomen brown; spermathecae two, small, subequal and pyriform in shape.

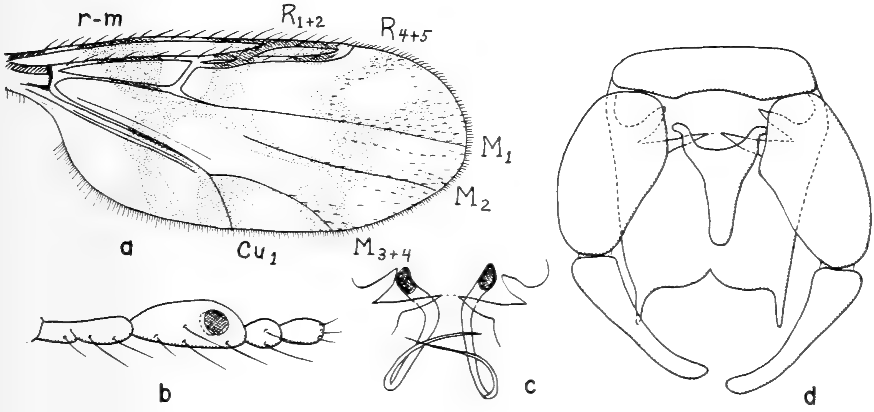
Male genitalia (Fig. 1, *c, d*). Ninth sternite very short with very shallow mesal excavation, the membrane bare; ninth tergite short, quadrate, with very small, widely separated, apicolateral processes. Basistyles stout, ventral roots stout and boat-hook shaped, dorsal roots not so long and rather stout; dististyles nearly straight, gradually tapered to tips which are blunt and not bent. Aedeagus short and stout, basal arms stout and forming anterior arch to half of total length; apex stout and rounded with faint serrations and apparently a few appressed, sharp, flattened, subapical spines. Parameres (Fig. 1, *c*) with bases knobbed; stems curved gently, each with ventral pouch about one-and-one-half times as long as its diameter, distal portions narrowed, tapered to sharp apical points with three or four subapical lateral barbs.

Holotype ♀, allotype, Mojinga Swamp, Fort Sherman, Canal Zone, October 24, 1951, F. S Blanton (light trap) (type no. 61497, U.S.N.M.). Paratypes: 12 ♂♂, 54 ♀♀, same data as type; 2 ♂♂, 2 ♀♀, Loma Boracha, C. Z., October 29, 1951.

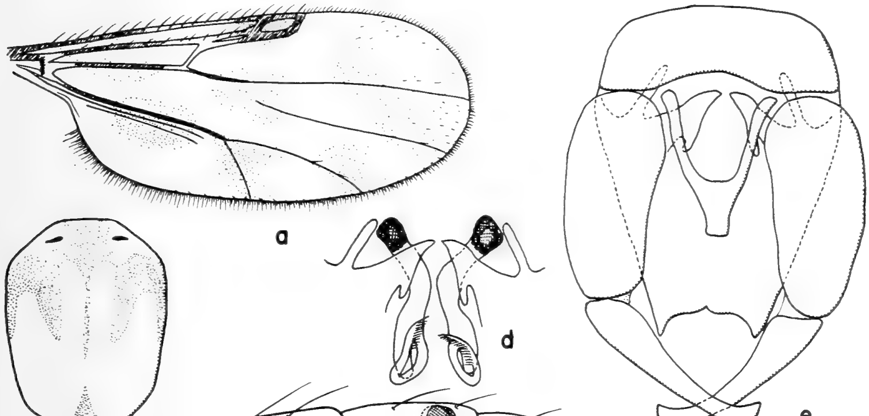
Apparently related to the next species, *kintzi* n.sp., which it superficially resembles in its uniformly tawny yellow color, wings with costa elongated, the apex in a light area, and the dark markings of the wing reduced, diffuse, and in cell R_5, oblique. However, according to the male genitalia these species probably belong to different groups, since in *uniradialis* the ventral roots are boat-hook shaped and the parameres have a ventral pouch and distal barbs, all these being lacking in *kintzi*. The other known species, with few exceptions, which have the second



I. UNIRADIALIS



2. KINTZI



3. CARPENTERI

Fig. 1.—*Culicoides uniradialis: a*, Female wing; *b*, female palpus; *c*, male parameres; *d*, male genitalia, parameres removed. Fig. 2.—*Culicoides kintzi: a*, Female wing, with important veins labeled; *b*, female palpus; *c*, male parameres; *d*, male genitalia. Fig. 3.—*Culicoides carpenteri: a*, Female wing· *b*, mesonotal pattern; *c*, female palpus; *d*, male parameres; *e*, male genitalia.

anterior radial cell in a light spot belong to the well defined *pulicaris* or *guttatus* groups with characteristic and greatly different male genitalia, usually contiguous eyes and distal, sensory tufts on some or all of the last five antennal segments.

Culicoides kintzi Wirth and Blanton, n. sp.

Fig. 2, *a–d*

♀. Length 1.0 mm, wing 0.9 mm by 0.4 mm. Head dark brown; eyes broadly separated, bare. Antennae with flagellar segments in proportion of 20:15:15:15:15:15:15:15:15:15:18:18:26, distal sensory tufts on segments 3, 8, 9, and 10. Palpal segments (Fig. 2, *b*) in proportion of 8:12:22:8:8, third segment moderately swollen with a small, shallow sensory pit.

Mesonotum rather narrow, color uniform dull brown, three very faintly indicated narrow, darker, longitudinal lines from level of humeral pits to scutellum, the latter concolorous with mesonotum. Postscutellum and pleura dark brown. Legs brown; femora with subapical, tibiae with sub-basal, narrow pale rings and mid and hind tibiae with apices broadly pale.

Wing (Fig. 2, *a*) with two complete anterior radial cells, both rather narrow; costa extending to 0.7 wing length; sparse macrotrichiae on distal third of wing. Wing markings practically the same as those of *uniradialis* n. sp., but only the tip of second anterior radial cell in a pale area; pale markings of wing predominant, but not to the degree found in *uniradialis*. Halteres pale.

Abdomen dark brown; spermathecae two, subequal, pyriform.

Male genitalia (Fig. 2, *c*, *d*). Ninth sternite short, with very shallow mesal excavation, the membrane bare; ninth tergite short and broad with very long, slender, apicolateral processes and a distinct mesal cleft at apex. Basistyles stout, ventral roots wedge shaped, the sharp points nearly meeting mesad, the dorsal roots shorter, curved and stout; diststyles slightly curved, gradually tapered to stout, blunt apices. Aedeagus stocky, with basal arms abruptly bent; distal portion stout, tapered to a bluntly rounded apex. Parameres (Fig. 2, *c*) with bases knobbed, stems very slender, abruptly curved just before basal fourth, the following portions slightly sinuate, abruptly bent at middle, the distal halves gradually tapered to slender, needlelike, simple points.

Holotype ♀, allotype, Mojinga Swamp, Fort Sherman, Canal Zone, October 24, 1951, F. S. Blanton (light trap) (type no. 61498, U.S.N.M.). Paratypes: 8 ♂♂, 42 ♀♀, same data except dates August 28 to November 28, 1951.

This species is superficially very similar to *uniradialis* n. sp., but is readily distinguished from it by the two completely formed radial cells, shorter costa, macrotrichiae at wing tips, and in the male, by the long apicolateral processes of the ninth tergite, slender, simple parameres, aedeagus with short basal arch and by the shape of the dorsal and ventral roots of the basistyles. *Culicoides pachymerus* Lutz, described from Amazonas, Brazil, appears to be closely related in the general wing pattern and in the shapes of the anterior radial cells, but the description is too scanty to make a close comparison. In *pachymerus*, however, the dark wing markings are more extensive and the fore and hind tibiae are said to be greatly swollen. We dedicate this species to Col. Francis B. Kintz, Surgeon of the U. S. Army Caribbean, whose cooperation made this study possible.

Culicoides carpenteri Wirth and Blanton, n. sp.

Fig. 3, *a–e*

♀. Length 1 mm, wing 1.0 mm by 0.45 mm. Head brown, eyes narrowly separated, bare. Antennae with flagellar segments in proportion of 20:15:18:18:18:18:18:18:30:30:35:40:50, distal sensory tufts on segments 3, 11, 12, 13, 14. Palpal segments (Fig. 3, *c*) in proportion of 10:40:30:12:12, third segment scarcely swollen, with broad, shallow, sensory pit near apex.

Mesonotum (Fig. 3, *b*) elongate; color tawny yellowish brown, anterior portion except humeri darker brown and a fine median line and a sublateral pair of broader longitudinal bands of brown extending caudad to about middle of mesonotum. Scutellum dark in middle; postscutellum and pleura dark brown. Legs dark brown, femora with basal and subapical, tibiae with sub-basal and hind tibiae with apical, rather wide, pale bands.

Wing (Fig. 3, *a*) with anterior radial cells complete, narrow; costa to 0.6 of wing length; macrotrichia very sparse, appearing only on distal fourth of wing in cells R_5, M_1, and M_2. Wing predominantly pale, a very dark, blackish, stigmal spot over second anterior radial cell and distal third of first; diffuse dark patches on wing just proximad of broad pale area around crossvein r-m, over vein M_{3+4}, Cu_1 midway between base and fork, halfway across cell R_5 behind stigmal spot, across middle of distal half of cell R_5 and continued along vein M_1 to wing tip forming an oval pale spot at apex of cell R_5 at wing margin; narrowly at medial fork and across basal half of mediocubital fork and subapically across cell M_1 and M_2, cutting off semicircular, apical spots in these cells at wing margin. Halteres pale.

Abdomen whitish on basal half above, light brown elsewhere; spermathecae two, slightly unequal, ovoid to slightly pyriform, the bases of the ducts sclerotized for a distance of a fourth of length of spermathecae.

Male genitalia (fig. 3, *d*, *e*). Ninth sternite short with shallow mesal excavation, the posterior membrane bare; ninth tergite tapered to a pair of broadly separated, triangular apicolateral processes. Basistyles with ventral roots large and boat-hook shaped, their apices nearly touching mesad, dorsal roots nearly as long, slender; dististyles slightly curved, slender, with slightly enlarged, pointed apices. Aedeagus with basal arch rounded, extending to two-thirds of total length, the very short distal portion broad with truncated apex. Parameres (Fig. 3, *d*) with knobbed bases, rather stout stems bent at about half their lengths, each with a distoventral pouch of same diameter as stem and about 1.5 times as long; apical portions about half the diameter of stems, tapered to pointed apices and each with a subapical fringe of about a dozen very fine hairs.

Holotype ♀, Madden Dam, Canal Zone, June 6, 1951, F. S. Blanton (light trap) (type no. 61500, U.S.N.M.). Allotype, Mojinga Swamp, Fort Sherman, C. Z., December 10, 1951. Paratypes: 16 ♀♀, same data as holotype; 24 ♀♀, same data as allotype, except dates August 15 to December 10, 1951; 1 ♀, Loma Boracha, C. Z., October 23, 1951; 2 ♀♀, Fort Sherman, C. Z., June 7, 1951; 1 ♀, Barro Colorado Island, January–March 1944, J. Zetek.

The Barro Colorado Island specimen was included by Barbosa as a paratype of *panamensis*, which however, is a much different species, with a light spot straddling vein M_2 of the wing. *C. carpenteri* might be confused with pale specimens of *galindoi* n. sp., but by microscopic examination of the female palpi and male genitalia the two species may readily be separated. We are pleased to have the opportunity to name this species in honor of Col. Stanley J. Carpenter, formerly entomologist for the U. S. Army Caribbean, whose interest in the Panama *Culicoides* problem gave great impetus to this project.

Culicoides galindoi Wirth and Blanton, n. sp.

Fig. 4, *a–f*

♀. Length 1.0 mm, wing 0.9 mm by 0.38 mm. Head brown; eyes contiguous, bare. Antennae with flagellar segments in proportion of 20:15:15:15:15:15:15:15:25:25:30:30:40, distal sensory tufts on segments 3, 7, 8, 9, 10. Palpal segments (Fig. 4, *c*) in proportion of 10:20:20:8:10, third segment slightly swollen, with well developed subapical sensory pit.

Mesonotum (Fig. 4, *b*) rich brown, on anterior half with extensive pruinose yellowish brown markings; principally a large pair of submedian patches and two sublateral pairs of smaller spots; posterior half almost entirely pale; scutellum dark in middle. Postscutellum and pleura dark brown, almost black. Legs dark brown, fore and mid femora with subapical, and all tibiae with subbasal, narrow pale rings.

Wing (Fig. 4, *a*) nearly bare, sparse macrotrichia distad of level from end of costa to end of vein M_{3+4}; anterior radial cells short, complete, costa to 0.6 of wing length. Second anterior radial cell and distal half of first included in a very dark spot; a very light spot over r-m crossvein from anterior wing margin to level of anterior media; a double light spot in cell R_5 at end of costa, a very large rounded light spot at apex of cell R_5, broadly meeting wing margin and usually continued along it a little way toward wing tip; two long light spots in cell M_1, the second broadly meeting wing margin; base of cell M_2 with continuous light streak to transverse dark band at level of end of vein M_{3+4} and a broad apical light spot at wing margin; base of anal cell pale and a large double light spot at apex. Halteres pale.

Abdomen dull, brownish black; spermathecae two, subequal, pyriform (Fig. 4, *d*).

Male genitalia (Fig. 4, *e*, *f*). Ninth sternite very short, with shallow mesal excavation, the membrane spiculate; ninth tergite short and strongly tapered, with very short, triangular, apicolateral processes. Basistyles stout, dorsal roots slender, ventral roots longer and boat-hook shaped; their apices contiguous mesad; dististyles slender, with curved, pointed apices. Aedeagus with strong basal arch, the basal arms slender and curved, apex a short, rounded lobe. Parameres (Fig. 4, *e*) with crooked, knobbed bases, the stems slender and slightly sinuate, the apices abruptly recurved ventrad, each with three subapical lateral barbs.

Holotype ♀, allotype, Mojinga Swamp, Fort Sherman, Canal Zone, October 24, 1951; F. S. Blanton (light trap) (type no. 61501, U.S.N.M.). Paratypes: 26 ♂♂, 38 ♀♀, same data as types, except dates August 15 to October 24, 1951; 1 ♀, Cerro Campaña, Panama Prov., July 3, 1951; 1 ♀, Pacora, Panama Prov., June 4, 1951; 2 ♂♂, 1 ♀, Madden Dam, C. Z., September 21, 1951; 1 ♀, Arraijan, Panama Prov., August 8, 1951; 9 ♂♂, 13 ♀♀, Loma Boracha, C. Z., October 29, 1951.

Culicoides limai Barretto, from São Paulo, Brazil, is very similar but has a small ventral lobe on the male parameres, the basal arch of the aedeagus is narrower, the mesonotum has only a pair of small, anterior, sublateral pale patches; the scutellum is dark on the extreme ends as well as in the middle, and the tibiae have subapical pale bands on the fore and mid legs and at the bases and apices of the hind pair. From the original description, *wokei* Fox might be confused with *galindoi*, but Fox's species is larger, the mesonotum has a faintly mottled pattern of punctiform dots and the wing is nearly bare with the markings very faint and diffuse. This species is named in honor of Dr. Pedro Galindo, of the Gorgas Memorial Laboratory, one of the leaders of the Panamanian Republic in the work on Diptera of medical importance.

Culicoides vargasi Wirth and Blanton, n. sp.

Fig. 5, *a–e*

♀. Length 1.0 mm, wing 0.9 mm by 0.42 mm. Head pruinose dark brown; eyes nearly contiguous, bare. Antennae with flagellar segments in proportion of 15:12:12:12:12:12:12:12:20: 22:25:28:36, distal sensory tufts on segments 3 and 7–10. Palpal segments (Fig. 5, *c*) in proportion of 8:12:25:9:11, third segment swollen with a broad, shallow, subapical, sensory pit.

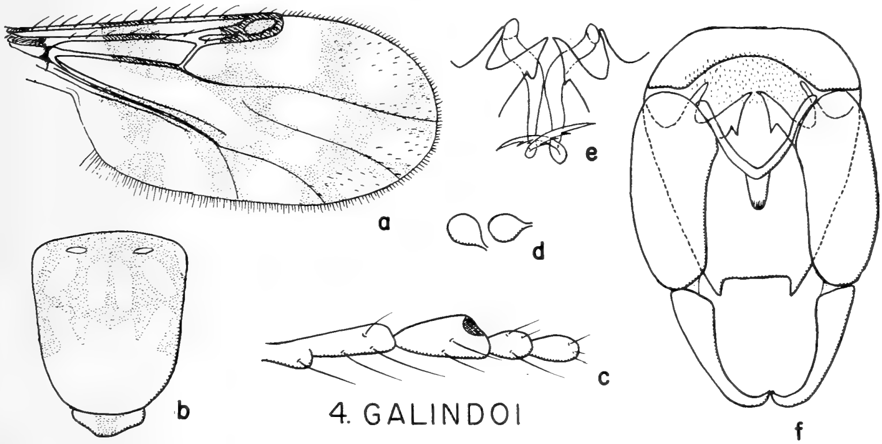
Mesonotum (Fig. 5, *b*) dark brown, with prominent pattern of large, pruinose gray patches, including a large, contiguous, quadrate pair in middle before suture, a pair of rounded spots over humeral pits, three pairs of rounded, lateral spots and quadrate prescutellar sensory areas margined with gray. Scutellum gray, brown in middle. Legs brown, femora with subapical and tibiae with subbasal pale bands, hind tibiae with apices broadly pale.

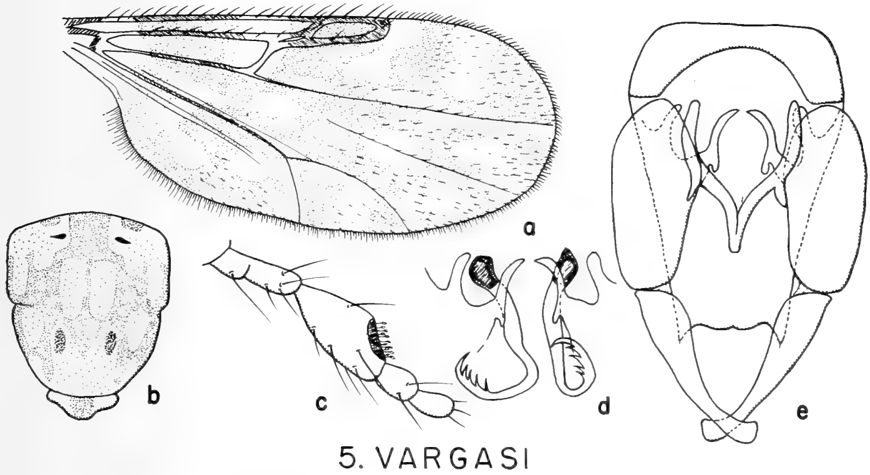
Wing (Fig. 5, *a*) with anterior radial cells normal, short; costa to 0.6 of wing length; macrotrichia very sparse and in rows over distal third of wing, a few in anal cell. Prominent yellow spots on anterior wing margin at wing base and over r-m crossvein, the latter spot extending to slightly behind anterior media, the area between these two spots and a stigmal spot over second anterior radial cell and distal half of first very dark. Cell R_5 with two hourglass-shaped, transverse light spots, the first just past end of costa, often divided into two separate, round spots, the second midway between this one and wing tip, both broadly meeting wing margin; cell R_5 also with two linear pale spots on anterior side of vein M_1, the first one short, midway between pale spot over r-m crossvein and one at end of costa, the second extending between posterior ends of the two anterior pale spots in cell R_5. Apices of veins M_1 and M_2 pale margined; a prominent light spot straddling middle of vein M_2; small, rounded, submarginal light spots in cells M_1 and M_2; cell M_2 also with a large light spot behind medial fork and a small light spot just in front of mediocubital fork; veins M_{3+4} and Cu_1 entirely pale margined, the latter broadly so, the former broadly connected to a large light spot in cell M_4 which broadly meets wing margin midway of cell, anal cell with basal pale spot connected to pale areas at base of cell M_2 and with a single, round light spot just behind mediocubital fork. Halteres pale.

Abdomen dark brown; spermathecae two, subequal, pyriform.

Male genitalia (Fig. 5, *d*, *e*). Ninth sternite with broad, deep, mesal excavation, the posterior membrane bare; ninth tergite long and tapered, the apicolateral processes short and triangular. Basistyles with ventral roots long, curved and slender, with small caudal hook; dorsal roots almost as long; dististyles slender and slightly curved. Aedeagus with basal arms broadly separate to two-thirds of total length, the fork angular, a pair of short, bladelike processes on caudal side of shoulders of basal arms; distal portion slender, with rounded apex with faint serrations. Parameres (Fig. 5, *d*) with large basal knobs, stems slender and nearly straight, abruptly recurved at distal three-fifths with apices narrowed and each bearing a fringe of 4–5 sharp spines and a strong, bent, distal spine.

Holotype ♀, allotype, Las Tablas, Los Santos Prov., Panama, June 14, 1951, F. S. Blanton (light trap) (type no. 61502, U.S.N.M.). Paratypes: 9 ♂♂, 10 ♀♀, same data as type; 12 ♂♂, 59 ♀♀, Mojinga Swamp, Fort Sherman, C. Z., August 28, 1951 to January 1952; 1 ♂, Río Hato, Cocle Prov., September 24, 1951.





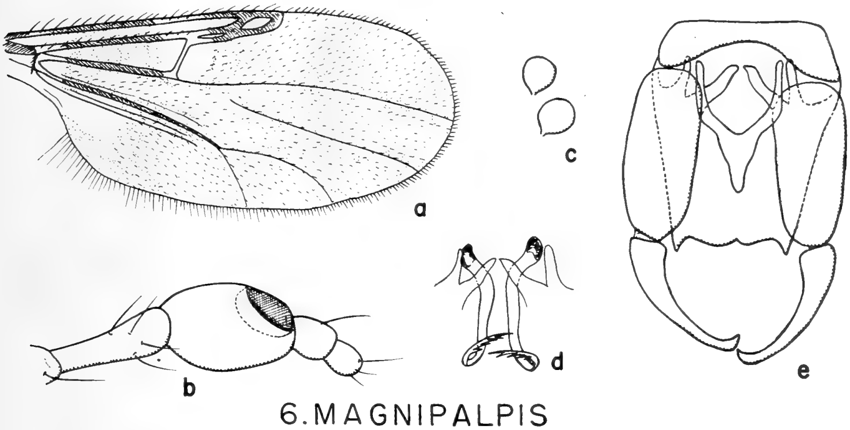


FIG. 4.—*Culicoides galindoi: a*, Female wing; *b*, mesonotal pattern; *c*, female palpus; *d*, female spermathecae; *e*, male parameres; *f*, male genitalia. FIG. 5.—*Culicoides vargasi: a*, Female wing; *b*, mesonotal pattern; *c*, female palpus; *d*, male parameres; *e*, male genitalia. FIG. 6.—*Culicoides magnipalpis: a*, Female wing; *b*, female palpus; *c*, female spermathecae; *d*, male parameres; *e*, male genitalia.

Other material examined: VENEZUELA, 3 ♂♂, 11 ♀♀, Ocumare del Tuy, May 28, 1951, I. Ortiz.

This species is the Neotropical counterpart of *baueri* Hoffman, which it very closely resembles. In *baueri*, described from Maryland, there is only one pale line bordering the anterior side of vein M_1, this located directly behind the light spot at the end of the costa; the hind femora lack the subapical pale rings and the hind tibiae lack the apical pale bands; the pit on the third palpal segment is small and deep and the spermathecae are subspherical. There are, however, no important differences in the male genitalia. We dedicate this species to Dr. Luis Vargas, of the Instituto de Salubridad y Enfermedades Tropicales, México, D. F., México, a very enthusiastic and esteemed worker on Neotropical *Culicoides*.

Culicoides magnipalpis Wirth and Blanton, n. sp.

Fig. 6, *a–e*

♀. Length 1.1 mm, wing 1.0 mm by 0.48 mm.

Head dark brown; eyes bare. Antennae with flagellar segments in proportion of 20:15:18:20:20:20:20:20:25:25:25:30:40, distal sensory tufts on segments 3 and 11–15. Palpal segments (Fig. 6, *b*) in proportion of 10:20:30:8:7, third segment remarkably bulbously swollen with broad, deep, sensory pit on distal half.

Mesonotum tawny yellowish brown, a faint, contiguous pair of lighter yellowish, oval, submedian spots on disc; humeral corners with a small pair of whitish spots; area between these and sensory pits blackish; scutellum tawny, slightly darker in middle. Postscutellum and pleura blackish, the latter pale on upper half. Legs dark brown, femora with subapical and tibiae with subbasal, narrow pale rings, distal tarsal segments pale.

Wing (Fig. 6, *a*) with anterior radial cells complete: costa to 0.6 of wing length: macrotrichia long and numerous, extending to base of wing except in basal cell. Anterior margin of wing with yellowish spots at wing base, over r-m crossvein (extending only to anterior media), a large rounded spot at end of second anterior radial cell extending two-thirds way to vein M_1 and a large pale oval spot nearly filling distal half of cell R_5 past level of end of costa. Cell M_1 with two light spots, the distal one broadly attaining wing margin: cell M_2 with a long pale spot just ahead of mediocubital fork, and a second rounded spot broadly attaining wing margin. Cell M_4 with a large rounded spot in distal half: anal cell with one large pale spot in distal portion. Halteres pale.

Abdomen dark brown: spermathecae (Fig. 6, *c*) two, subequal, subspherical.

Male genitalia (Fig. 6, *d*, *e*). Ninth sternite with broad, deep mesal excavation, the posterior membrane bare: ninth tergite slightly longer than basal breadth, apicolateral processes short and widely separated, a slight median cleft. Basistyles with ventral roots slightly foot-shaped, their pointed apices nearly meeting mesad; dorsal roots slightly shorter, slender and simple; dististyles slender, slightly curved, their apices bent and pointed. Aedeagus with basal arch to slightly over half of total length, the basal arms stout and bent midway forming a rooflike arch; distal portion stout at base, apex narrower and rounded. Parameres (Fig. 7, *d*) with bases knobbed, stems slender, bent near bases, middle portions straight, then bent outward and then ventromesad with tips slender and needlelike and each bearing four lateral barbs.

Holotype ♀, allotype, Cerro Campaña, Panama, July 3, 1951, F. S. Blanton (light trap) (type no. 61503, U.S.N.M.). Paratypes: 4 ♀♀, same data as type.

This species takes its place near the *debilipalpis* group of species on the basis of its wing markings, but differs from them in having the distal light spots attaining the wing margin in cells R_5, M_2, and M_4, and the third palpal segment is very distinctively swollen.

LITERATURE CITED

BARBOSA, F. A. Culicoides *(Diptera; Heleidae) da regiao Neotropica.* An. Soc. Biol. Pernambuco **7:** 3–30. 1947.

FOX, I. *A review of the species of biting midges or* Culicoides *from the Caribbean region (Diptera: Ceratopogonidae).* Ann. Ent. Soc. Amer. **39:** 248–258. 1946.

———. Hoffmania, *a new subgenus in* Culicoides *(Diptera: Ceratopogonidae).* Proc. Biol. Soc Washington **61:** 21–28. 1947.

———. *Two new Central American biting midges of* Culicoides *(Diptera: Ceratopogonidae).* Kuba **3:** 90–91. 1947.

MACFIE, J. W. S. *Some species of* Culicoides *(Diptera, Ceratopogonidae) from the state of Chiapas, Mexico.* Ann. Trop. Med. and Parasitol. **42:** 67–87. 1948.

Ortiz, I. *Estudios en* Culicoides. Rev. Sanid. y Assist. Social **15**: 429–465. 1950.

———. *Estudios sobre* Culicoides *(Diptera, Ceratopogonidae)* VII. Culicoides dominicii *n. sp. y clave para el reconocimiento de las especies venezolanas*. Nov. Cient. Mus. Hist. Nat. La Salle, Zool. Ser., no. 5, 12 pp. 1951.

Wirth, W. W. *The Heleidae of California*. Univ. California Publ. Ent. **9**: 95–266. 1952.

ENTOMOLOGY.—Wenzella obscura, *a new genus and new species of flea from Guatemala (Siphonaptera)*.[1] Robert Traub, Lt. Col., MSC.[2]

The siphonapteran fauna of Guatemalan rodents, although of potential medical significance, is relatively little known. Among the excellent ectoparasites collected by a Chicago Natural History Museum expedition to Guatemala in 1948, is the remarkable flea here described as a new genus of the family Hystrichopsyllidae, subfamily Rhadinopsyllinae.

Wenzella, n. gen.

Diagnosis.—Differs from all known rhadinopsylline genera in *each* of the following characteristics: Pronotal comb lacking; antenna with a conspicuous flange (Fig. 1, *A.F.*) extending from base to near apex of club, ensheathing much of first two segments; lacking even vestiges of abdominal comb of spinelets on terga two through six; prosternosome without a sinus to receive the small first vinculum (*VC.1*); fourth vinculum distinct (Fig. 10, *VC.4*); male with three antesensiliary bristles; male eighth tergum (Fig. 7, *8T.*) very large, inclosing much of genitalia; maxillary palpi (Fig. 1, *M.P.*) very long, extending to apex of foretrochanters, suggesting *Megarthroglossus* of Anomiopsyllinae.

Agrees with *Stenischia* Jordan, 1932, in that the lateral metanotal area is not set off as a distinct sclerite, and instead the metanotum extends as a downward-directed long vertical triangle between metepisternum and metepimere.[3] Differs from other members of the subfamily (except *Trichopsylloides* Ewing, 1938) in lacking a genal ctenidium.

Description.—Caput integrecipitate, with internal but distinct tubercle (Fig. 1, *TB.*). Anterior and dorsal margins of head evenly and very broadly convex, not rounded; in female, those margins straighter. Genal region (*GN.*) extending downward beyond mid-point of maxillary lobe. Head chaetotaxy reduced in number and size of bristles, which are not set in distinct rows; postantennal region with but one row of bristles, that marginal. Eye greatly reduced. Palpi (*L.P.*) 5-segmented, not extending beyond apex of forecoxae, much shorter than elongate maxillary palpi. Antenna peculiar in position and shape; although genus is integrecipitate in both sexes, in each sex the base of antenna is removed from crown of head (in other integrecipitate fleas, that of male is usually near top of head); antennal groove not definitely extending onto propleuron; first antennal segment directed anteriorly, almost horizontal, not pointing ventrad as is typical in other fleas; club almost rhomboidal, scarcely narrowed apically, its segments often partially fused, some reduced in size; club apparently consisting of seven or eight segments (actually nine present); with a conspicuous triangular flange. First vinculum (*VC.1*) relatively broad. Margin of prosternosome straight, unmodified at level of insertion of this vinculum. Tentorial bridge (*T.BR.*) unusual in being displaced caudad, near vinculum (overlapping in specimen drawn); vermiform. Pronotum with but one complete row of bristles, those short; comb completely absent. Mesonotum (Fig. 10, *MSN.*) with two rows of bristles, the first somewhat irregular; with a relatively long, well-developed phragma (*PH.2*); with two or three pseudosetae (*PS.S.*). Mesepisternum (*MPS.*) with anterior margin fairly straight. An internal furca (*I.F.2*) conspicuous, extending dorsad more than half height of mesepimere (*MPM.*). Mesepimere longer than broad (high), much longer than *MPS.* Mesosternosome (*MPS.* and *MPM.*) with chaetotaxy reduced to about four bristles. Metanotum (*MTN.*) with a distinctive beak-shaped conspicuous phragma (*PH.3*) (not as broad as that of mesonotum); with two rows of bristles; about

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[1] Published under the auspices of the Surgeon General, Department of the Army, who does not necessarily assume responsibility for the professional opinions expressed by the author.

[2] Department of Entomology, Army Medical Service Graduate School, Walter Reed Army Medical Center, Washington, D. C.

[3] In *Trichopsylloides* Ewing the metanotum is similarly downward-directed, but the lateral metanotal area is fairly well defined.

as long as mesonotum and about half again as long as pronotum (ignoring phragma). Sides of metanotum extending ventrad as a downward-pointing triangle, the altitude of the triangle about equal to that of rest of notum above it. Lateral metanotal area completely absent. Pleural arch absent. Lower margins of metanotum heavily sclerotized, as is posterior margin of metepisternum (*MTS.*). Metepisternum (*MTS.*) with anterior margin ventrally straight, its upper portion concave. With a conspicuous internal furca (*I.F.3*) arising from base of *MTS*. Squamulum absent. Metepimere (*MTM.*) well developed, broader than long; lacking a striarium; chaetotaxy relatively reduced; apparently not fused with metanotum, although margins contiguous.

Metacoxa lacking the subapical patch of spiniforms or subspiniform bristles characteristic of the subfamily (also missing in *Trichopsylloides* Ewing, 1938, and in *Paratyphloceras* Ewing, 1940). Tibial comb absent. Profemur without thin lateral or mesal bristles. Fifth tarsal segment on each leg with four pairs of lateral plantar bristles, the apical pair somewhat reduced.

Typical terga with two rows of bristles. Second abdominal sternum without a striarium. With three antesensiliary bristles (Fig. 7, *A.B.*) in each sex; the bristles relatively unmodified; the plate supporting these bristles unusual in being displaced from dorsal and caudal margins. Abdominal spiracles much longer than broad.

Male eighth tergum extending beyond base of clasper. Male eighth sternum very large, with many bristles. Movable finger (Fig. 9, *F.*) long and narrow, without spiniforms. Ninth sternum with distal arm (Fig. 7, *D.A.9* and fig. 5) bearing subspiniforms; proximal arm (*P.A.9*) weakly sclerotized. Aedeagus relatively unmodified; with pouch wall (Fig. 8, *P.W.*) lightly sclerotized. Anal stylet (Fig. 2, *A.S.*) of female with a long apical bristle and dorsal and ventral subapical bristles. Sensilium somewhat convex. Abdominal bristles (particularly those of male eighth sternum) set in prominent bases (Figs. 6 and 4).

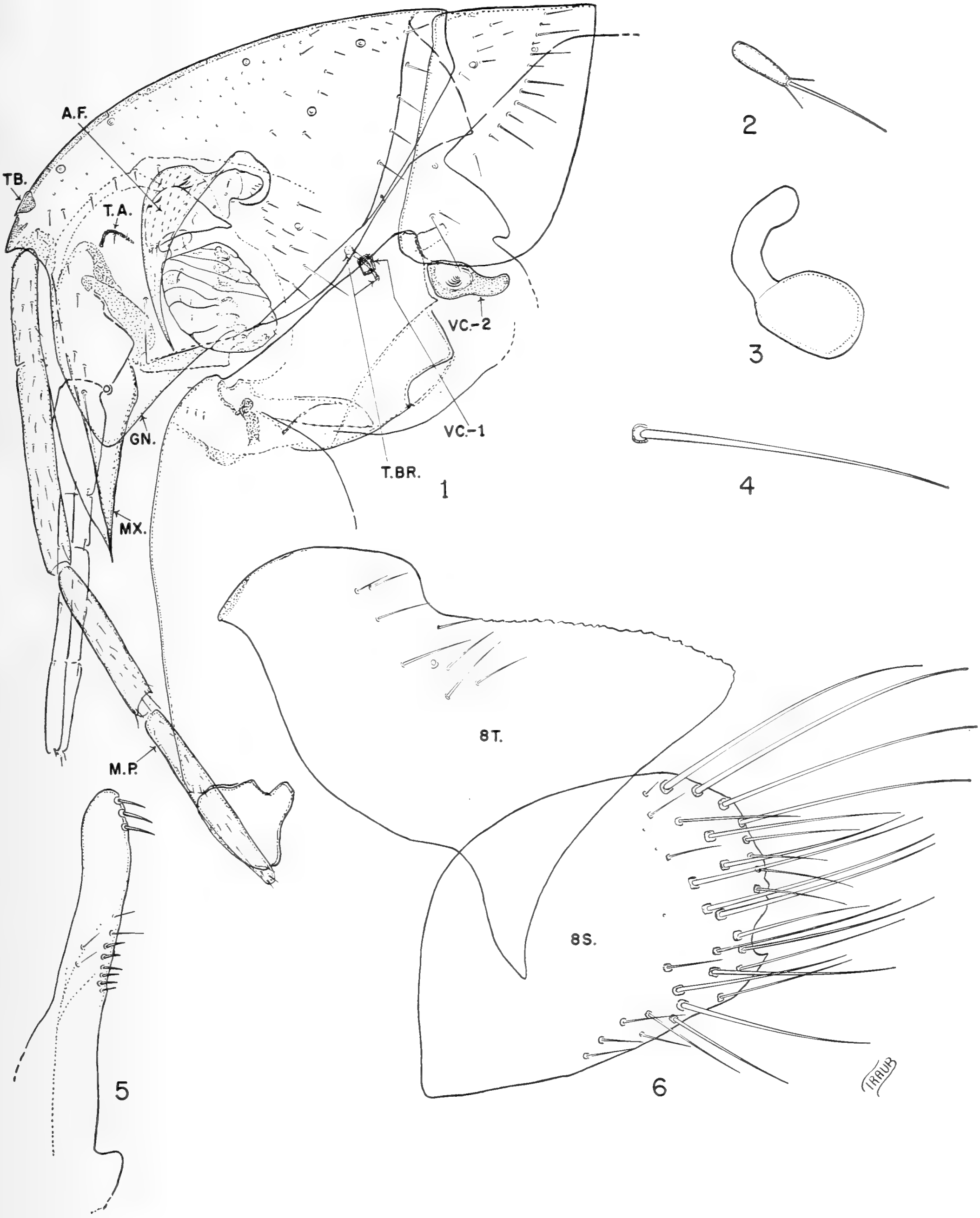
Genotype: *Wenzella obscura*, n. sp. The genus is named for Rupert L. Wenzel, curator of insects, Chicago Natural History Museum, who has contributed very much to the study of ectoparasites and who organized and led the expedition which collected this exceptionally interesting flea.

Wenzella obscura, n. sp. (Figs. 1-11)

Types.—Holotype male and allotype female ex *Heteromys d. desmarestianus* Grey (family Heteromyidae), a spiny pocket mouse; Guatemala: Sacatepequez, 6 km west of Mixco; elevation, 6,900 feet; collected by R. Mitchell and L. de la Torre; June 26, 1948. Six male and five female paratypes with same data. Holotype and allotype deposited in collections of the Chicago Natural History Museum. Paratypes deposited in the United States National Museum; the British Museum (Tring); the Division of Entomology, Department of Agriculture, Ottawa, Canada; the Chicago Natural History Museum; and the author's collection.

Description.—HEAD, MALE (Fig. 1): Anterior margin of head a shallow arc; in female nearly straight so that head is almost pointed. Preantennal region with a vestige of a row of seven or eight rudimentary bristles or hairs extending from insertion of maxillary palpi to antennal groove; with an "ocular" row of two small bristles, one near antennal groove and the other ventromarginal; with about eight to ten thin hairs scattered on rest of genal area. Anterior arm of tentorium (*T.A.*) visible on each side as an angled vermiform structure. Eye absent. Maxillary lobe (*MX.*) extending to near apex of second segment of maxillary palpus (*M.P.*). Gena (*GN.*) conspicuous, produced downward as a flap on each side, extending to near midpoint of second segment of maxillary palpus. True genal lobe (at area of junction with antennal groove) inconspicuous. Second segment of maxillary palpi about twice the length of first, larger than third, and subequal in length to fourth, which extends to about apex of foretrochanters. The labial palpi weakly sclerotized, extending to about apex of forecoxae. Postantennal region with very small thin vestigial bristles or hairs, pattern suggesting vestigial rows arranged 4-5-5, those of last row longest although still small; in addition, a patch of about 11 similar bristles near antennal groove; longest postantennal bristle at ventrocaudal angle. First segment of antenna with three to five tiny hairs at base and three or four scattered marginal hairs. Second segment bonnet-shaped, with one or two lateral bristles and a marginal row of hairs; the segment directed ventrad. Club of antenna rhomboidal but with ventral margin slightly convex apically; club about three-fourths as broad as long; with nine compact segments partially fused so that joints are inapparent, appearing to have merely seven or eight segments. Antennal flange covering most of second segment and extending beyond midpoint of club. First vinculum or link plate (*VC.1*) less than twice as long as broad, anterior and posterior margins more sclerotized than remainder of link plate.

THORAX: Pronotum with first row of bristles shorter than second, extending down to about mid-point of segment. In addition, with two bristles near anteroventral angle. In each sex, prosternosome with an indication of a sinus for



WENZELLA OBSCURA GEN. & SP. NOV.

FIG. 1.—Head and prothorax, male. FIG. 2.—Anal stylet. FIG. 3.—Spermatheca. FIG. 4.—Bristle of male eighth tergum. FIG. 5.—Distal arm of male ninth sternum. FIG. 6.—Eighth tergum and eighth sternum, male.

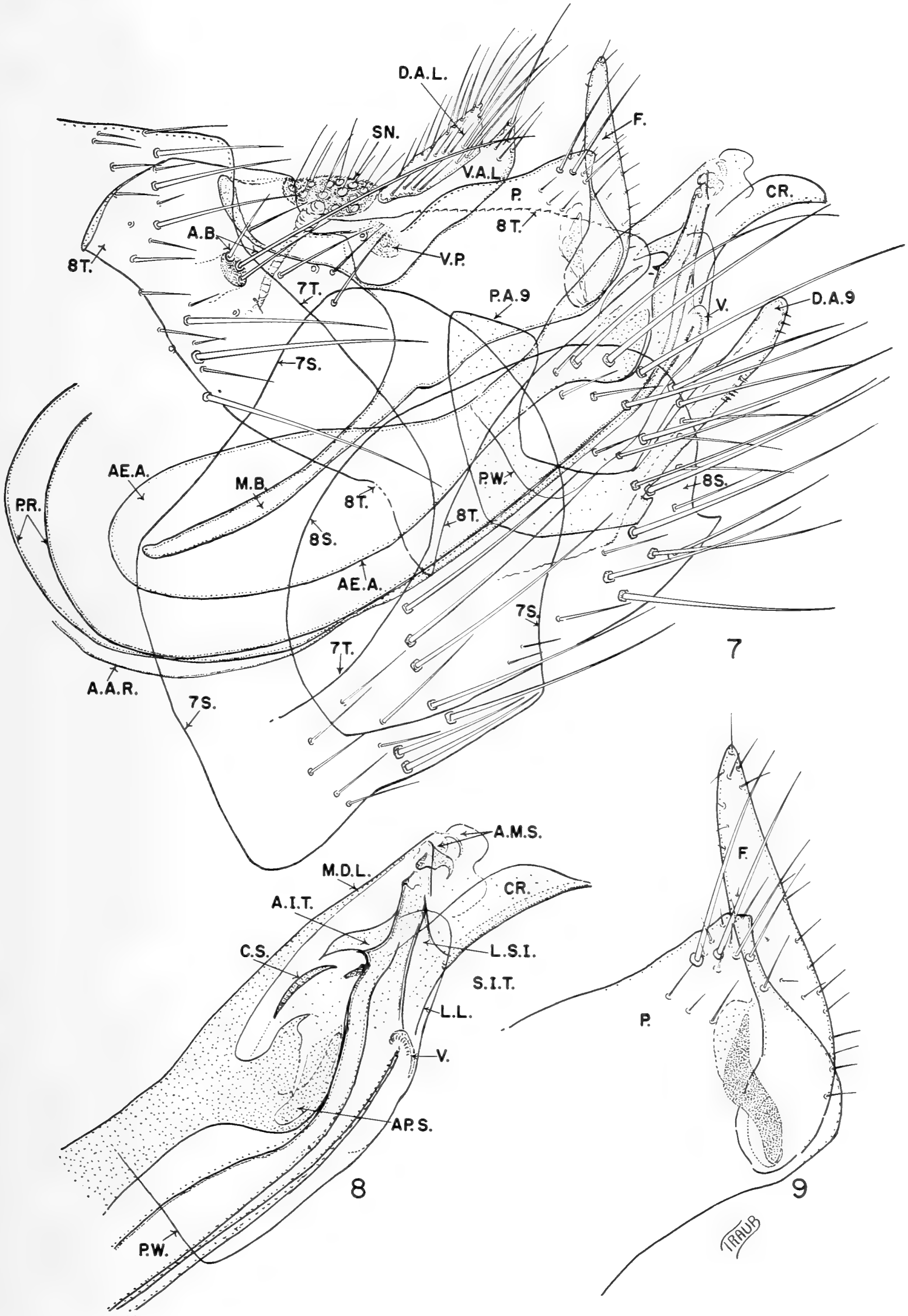
receipt of antennal club. Mesonotum (Fig. 10, *MSN.*) three-fourths as long as broad, excluding the conspicuous, cephalad-directed phragma (*PH.2*); mesonotal phragma triangular, its anterior margin extending down to ventral sixth of notum and then with base of triangle emarginate; with two rows of bristles, anterior row short and terminating near level of anterior lucodisc (*LD.*); posterior row terminating above second lucodisc. Mesonotal flange with three pseudosetae (*PS.S.*) per side, all inserted above mid-point. Mesepisternum (*MPS.*) with one bristle near ventrocaudal angle. Mesepimere (*MPM.*) with three bristles, two of these ventral, the third above insertion of third vinculum (*VC.3*). Internal furca (*I.F.2*) of mesosternum irregular, relatively conspicuous, arising caudad to mesosternal rod; broad at base; apically narrow; extending dorsad to level of spiracle. Metanotum (*MTN.*) with two rows of bristles, the first short; about two-thirds as long as broad (measured at maximum, including breadth or height from dorsal margin to apex of ventral triangular extension); phragma of metanotum (*PH.3*) beak-shaped, about as long as broad; without indication of a lateral metanotal sclerite; apical spinelets absent. Mesepisternum (*MTS.*) with a caudomarginal bristle near mid-point; this margin heavily sclerotized. Internal furca (*I.F.3*) of metasternum well developed, vertical, extending about one third height of segment, narrowed above proximal third. Metepimere (*MTM.*) somewhat rhomboidal, but caudal margins slightly sinuate, very broad, i.e., breadth (height) greater than metanotum; with four bristles, two near bullet-headed spiracle, remaining two median. Fourth vinculum (*VC.4*), or link plate, vermiform.

Legs: Forecoxa with thin scattered lateral bristles from base to apex. Mesocoxa with basal two thirds naked; apical third with a few lateral submarginal stout bristles. Metacoxa similar to mesocoxa but with a few thin submarginal hairs on proximal two thirds. Femora with three ventromarginal bristles near apex. Tibia with a row of thin bristles flanking the stout dorsomarginal ones; these last stout bristles arranged 1-2-1-2-2-3 on all legs. Apical bristle of first segment of metatarsus reaching to apex of second; one apical bristle of second segment reaching to apex of third. Tarsal claws long and narrow; fifth tarsal segment with fourth lateral plantar bristles thinner and shorter than others; the fifth plantar bristle represented by a hair. Measurements (in microns) of tibiae and segments of tarsi (petiolate base deleted) of holotype are as follows:

Leg	Tibia	Tarsal Segments				
		I	II	III	IV	V
Pro-	125	60	50	40	35	80
Meso-	180	120	75	50	35	90
Meta-	225	200	125	70	40	100

Abdomen: First tergum (Fig. 10, *1T.*) with two rows of bristles, at times with an additional subdorsal bristle preceding the first row; first row extending to about mid-point of tergum; second row longer; with vestiges of two apical spinelets on flange; with a beak-shaped phragma (*PH.-1T.*) one and one-half times as long as broad at base; with two or three ventromarginal bristles. Basal sternum lacking a striarium; with a ventromarginal row of four to six or eight small bristles; other unmodified sterna with a row of six to eight long thin bristles preceded by three or four rows of shorter bristles: in instance of second sterna these anterior bristles irregularly arranged. Typical terga with two rows of bristles, the second row extending slightly below the sublanceolate spiracle, the anterior row somewhat shorter. Antesensiliary (antepygidial) bristles long and narrow in both sexes, relatively unmodified and resembling normal tergal bristles; in male (Fig. 7, *A.B.*) middle bristle almost thrice length of upper bristle; about twice length of lower; in female (Fig. 11, *A.B.*) about twice length of uppermost but ventral one three-fourths length of middle bristle. Plate bearing antesensiliary bristles displaced ventrad from dorsal margin a distance equal to length of dorsal bristle; displaced anterior of caudal margin a distance subequal to breadth of plate. Plate displaced even further in female.

Modified Abdominal Segments, Male (Fig. 7): Setal bases of abdominal bristles pronounced, heavily sclerotized. Eighth tergum (*8T.* and Fig. 6) extending caudad beyond base of digitoid and ventrad to level of base of distal arm of ninth sternum; with about eight small thin bristles near and below subovate spiracle; dorsal margin slightly crenulate from sensilium to near apex; with anterior and posterior margins convergent and meeting in a triangular extension; anterior margin doubly sinuate; posterior margin slightly concave. Eighth sternum (*8S.* and Fig. 6) large, extending dorsad to near apex of proximal arm of ninth sternum and caudad to middle of distal



WENZELLA OBSCURA GEN. & SP. NOV.

FIG. 7.—Modified abdominal segments, male. FIG. 8.—Apical portion of aedeagus. FIG. 9.—Immovable process and digitoid of clasper.

arm of ninth sternum; dorsal margin convex; caudal margin with a subventral sinus; with approximately 21 marginal and submarginal long bristles from base to apex; in addition, with six smaller ventromarginal bristles; long bristles on eighth sternum with setal bases even more heavily sclerotized than on other segments (Fig. 4).

Immovable process of clasper (*P.* and Fig. 9) broad, extending to about mid-point of digitoid (*F.*); apex broadly rounded or subtruncate; caudal margin sinuate; with three fairly long subapical bristles and about six small mesal subapical bristles; with about three caudomarginal bristles; two or three small thin mediolateral bristles proximad of subapical patch. Movable finger or digitoid (*F.*) long and narrow, about five times as long as broad at midpoint; apex subacuminate; caudal margin fairly straight, except where curving at base; anterior margin sinuate, curving caudad apically and at base curving rather sharply anteriorly; with a small thin apical bristle and a caudomarginal row of about 12 small thin bristles extending to near base, but with a gap from apical two thirds to near apex. With two or three similar subapical bristles and with a few small anteromarginal or submarginal bristles extending from below midpoint to near apex. Manubrium (*MB.*) long and narrow.

Ninth sternum weakly sclerotized for most of its length and hence difficult to see clearly except for apex of distal arm; proximal arm of ninth sternum (*P.A.9*) broad, apically truncate. Distal arm of ninth sternum (*D.A.9* and Fig. 5) longer than proximal arm and apically much narrower: apex with three caudomarginal supspiniforms; with a group of about five or six similar caudomarginal subspiniforms at apical two thirds; with two short thick bristles distad of proximal patch.

Aedeagal apodeme (Fig. 7, *AE.A*) about three and one-half times as long as broad; proximal spur and apical appendage absent. Median dorsal lobe (Fig. 8, *M.D.L.*) straight. Sclerotized inner tube (*S.I.T.*) fairly straight and unspecialized, its armature represented as a weakly sclerotized winglike expansion. Apicomedian sclerite (*A.M.S.*) on each side of *S.I.T.* consisting of two portions: a proximal short, caplike sclerite and a large apical weakly sclerotized, somewhat dumbbell-shaped structure. Lateral sclerotization of inner tube (*L.S.I.*) ill-defined. Crochet (*CR.*) consisting of a large troughlike sclerite extending well apicad of inner tube; dorsal margin slightly convex, parallel to ventral margin for most its length, but crochet subapically narrowing; ventral margin relatively heavily sclerotized. Lateral lobes (*L.L.*) narrow and extending to near apex of *S.I.T.*, apparently an undifferentiated portion of the semimembranous pouch wall (*P.W.*). Crescent sclerite (*C.S.*) well developed. Penis rods (*P.R.*) not fully coiled. Aedeagal apodemal rod (*A.A.R.*), the third penile rod, arising from the base of the almost invisible pouch wall. Vesicle (*V.*) fairly well developed. Apodemal strut (*AP.S.*) of usual type but sclerites not differentiated.

Tenth segment conspicuous; sensilium (Fig. 7, *SN.*) with about 12 pits per side. Dorsal anal lobe (*D.A.L.*) relatively well sclerotized, covered with bristles, those at apex long. Ventral anal lobe (*V.A.L.*) with long apical bristles, its outlines semimembranous for the most part. Proximal ventral sclerite of proctiger (*V.P.*) fairly well indicated.

MODIFIED ABDOMINAL SEGMENTS, FEMALE (FIG. 11): Seventh sternum (*7S*) with caudal margin produced into a blunt lobe; below this, margin evenly convex; with four rows of bristles arranged approximately 4-8-9, those of last row very long. Seventh tergum (*7T.*) emarginate at level of the plate of the antesensiliary bristles, which are displaced slightly more ventrad. Eighth tergum (*8T.*) very large, with two irregular rows of long thin bristles ranging from above spiracle to ventral margin; with about four long additional submarginal bristles near ventral sinus; posterior margin markedly produced caudad at level of ventral anal lobe. Eighth sternum (*8S.*) vestigial. Dorsal anal lobe (*D.A.L.*) with about eight mediolateral bristles and a fringe of dorsal bristles; with a longer bristle at ventrocaudal angle. Ventral anal lobe (*V.A.L.*) not heavily sclerotized, ventral margin sinuate; with about three or four long thin bristles near anteroventral angle and one or two subapical bristles. Anal stylet (*A.S.* and Fig. 2) about three times as long as broad, with long apical bristle and two shorter subapical ones. Spermatheca (*SP.* and Fig. 3) with tail slightly longer than head, upturned. Head somewhat longer than broad; subpyriform. Bursa copulatrix (*B.C.*) fairly well developed, globose, its duct rather short.

DISCUSSION OF THE STATUS OF THE GENUS WENZELLA

As will be seen from the diagnosis, *Wenzella* differs greatly from other members of the subfamily (i.e., *Nearctopsylla* Rothschild, 1915, *Corypsylla* C. Fox, 1908, *Para-*

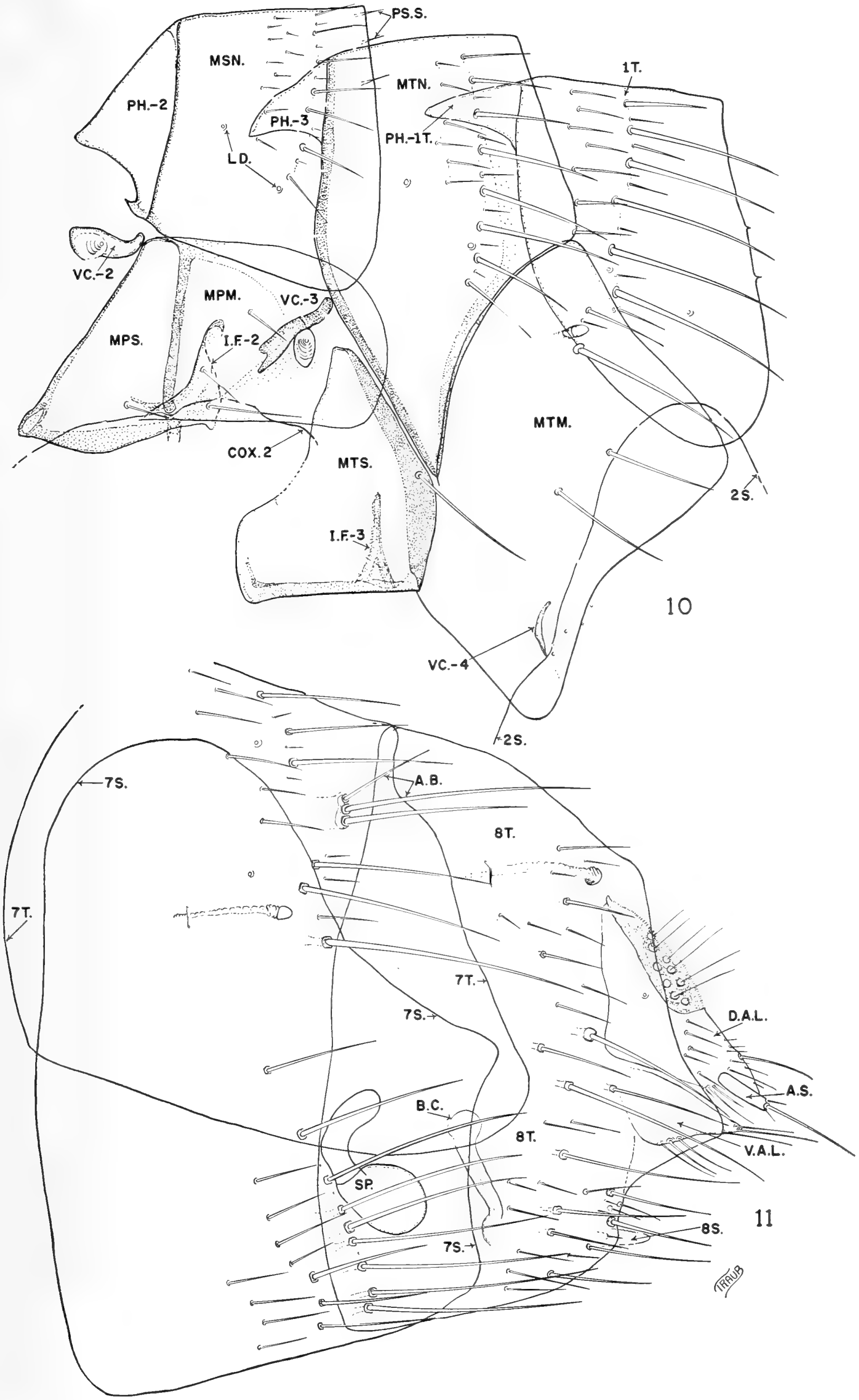


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Fig. 10.—Mesothorax and metathorax and first abdominal tergum, male. Fig. 11.—Modified abdominal segments, female.

typhloceras Ewing, 1940, *Trichopsylloides* Ewing, 1938, *Stenischia* Jordan, 1932, *Rhadinopsylla* Jordan and Rothschild, 1912, and *Rectofrontia* Wagner, 1930[4]). Certain of these differences are shared by genera in other subfamilies and these are thought to be due to convergent evolution. Thus, the elongate maxillary palpi suggest *Megarthroglossus* (subfamily Anomiopsyllinae). The new genus resembles *Anomiopsyllus* Baker, 1904, in the loss of pronotal and genal ctenidia as well as in the marked reduction in size and numbers of the head bristles. These adaptations are characteristic of fleas which ordinarily are restricted to the nests of the host (1, 2). The caudad displacement of the tentorial bridge (Fig. 1, *T.BR.*) is also suggestive of *Anomiopsyllus*. In *Rectofrontia* and allies, as in most fleas, the bridge arises at the level of the anteroventral portion of the antennal groove.

In its possession of a well-developed fourth vinculum (*VC.4*), *Wenzella* resembles the neopsylline and pygiopsyllid fleas. The absence of a sinus to receive the first vinculum is also characteristic of these last two groups of fleas. Nevertheless, the taxonomic assignment of *Wenzella* is clearly indicated by the possession of the following characters: fusion of the segments of the antennal club; at least one of the internal rods of the meso- and metacoxae is cut short, interrupted or abbreviated; the large vertical internal furca of the mesosterna and metasterna; the fusion of the lateral metanotal area with the metanotum. The subfamily Neopsyllinae includes fleas which differ in important details from *Wenzella* as follows: male antennal club unmodified, and also extending well onto propleuron (along with corresponding fossa); inner surface of hindcoxa with a patch of spiniforms or small bristles; aedeagus with a very well developed, long, broad pouch; characteristically possessing a striarium on second abdominal segment. The Pygiopsyllidae are essentially Australasian fleas, although one genus is known to occur in South America. In this group the genitalia are of a very different type, the sensilium is markedly convex, and there is no frontal tubercle. For these reasons the genus *Wenzella* is best placed in a new tribe of Rhadinopsyllinae characterized as follows:

Wenzellini, n. tribe

Clypeal tubercle internal. Integrecipitate, but the antennal groove removed from crown of head in both sexes. First vinculum not received in a distinct sinus of prosternum. Fourth vinculum present. Metepimeral striarium absent. Lacking a striarium on second abdominal segment. Inner side of hindtarsi virtually nude, lacking a patch of spiniforms or short bristles. Lateral metanotal area absent, the huge metanotum extending down between upper half of metepisternum and metepimere.

ACKNOWLEDGMENTS

I am very grateful to Dr. Karl Jordan, F. R. S., of the British Museum (Tring), who verified the status of this unusual flea, and to Miss Phyllis T. Johnson, of the Department of Entomology, Army Medical Service Graduate School, Washington, for critical review of the manuscript.

REFERENCES CITED

Traub, R. *Siphonaptera from Central America and Mexico*. Zool. Mem. Chicago Nat. Hist. Mus. **1**(1): 1–127, pls. 1–54. 1950.

Traub, R., and Tipton, V. J. Jordanopsylla allredi, *a new genus and species of flea from Utah* (*Siphonaptera*). Journ. Washington Acad. Sci. **41**(8): 264–270, 7 figs., 2 charts. 1951.

LIST OF ABBREVIATIONS

A.B.	antesensiliary bristle.
A.F.	antennal flange.
A.A.R.	third aedeagal rod (accessory apodemal rod).
A.M.S.	apicomedian sclerite.
A.S.	anal stylet.
AE.A.	aedeagal apodeme.
AP.S.	apodemal strut of aedeagus.
B.C.	bursa copulatrix.
C.S.	crescent sclerite.
CR.	crochet.
D.A.L.	dorsal anal lobe of proctiger.
D.A.9	distal arm of male ninth sternum.
F.	movable finger or digitoid of clasper.
GN.	gena.
I.F.2	internal furca of mesosternosome.
I.F.3	internal furca of metasternosome.
L.L.	lateral lobe of aedeagus.
L.P.	labial palpi.

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[4] *Micropsylloides* Ewing, 1938, *Ralipsylla* Ioff, 1946, *Actenophthalmus* C. Fox, 1925, and *Micropsylla* Dunn, 1923, are considered to be synonyms of *Rectofrontia* and at best are subgenera. G. H. E. Hopkins, of the British Museum (Tring), has independently expressed a similar opinion about these genera of the Rhadinopsyllini.

L.S.I.	lateral sclerotization of inner tube.
LD.	lucodisc.
M.D.L.	median dorsal lobe of aedeagus.
M.P.	maxillary palpi.
MB.	manubrium.
MPM.	mesepimere.
MPS.	mesepisternum.
MSN.	mesonotum.
MTM.	metepimere.
MTN.	metanotum.
MTS.	metepisternum.
MX.	maxillary lobe.
P.	immovable process of clasper.
P.A.9	proximal arm of male ninth sternum.
P.R.	penis rod.
P.W.	wall of aedeagal pouch.
PH.2	phragma of mesonotum.
PH.3	phragma of metanotum.
PH.-1T.	phragma of first abdominal tergum.
PS.S.	pseudosetae.
S.I.T.	sclerotized inner tube of aedeagus.
SN.	sensilium.
SP.	spermatheca.
T.A.	anterior arm of tentorium.
T.BR.	tentorial bridge.
TB.	frontoclypeal tubercle.
V.	vesicle of aedeagus.
V.A.L.	ventral anal lobe of proctiger.
V.P.	subanal sclerite.
VC.1	first vinculum or link plate.
VC.3	third vinculum or link plate.
VC.4	fourth vinculum or link plate.
7S.	seventh sternum.
7T.	seventh tergum.
8S.	eighth sternum.
8T.	eighth tergum.

ORNITHOLOGY.—*A taxonomic study of the American dunlin* (Erolia alpina *subspp.*). W. E. Clyde Todd, Carnegie Museum, Pittsburgh, Pa. (Communicated by Herbert Friedmann.)

The red-backed sandpiper, or dunlin, like certain of its affines, is circumboreal and Holarctic in its breeding range; unlike many of them, however, it does not retire into the Southern Hemisphere for the winter, but spends that season in more temperate climes. A common and well-known shorebird, it received its specific name *alpina* from Linnaeus in 1758. Obviously, it must have been one of the species he himself observed on his trip to Lapland in 1752, since he quotes no other authority. In 1766, however, failing to identify his bird with Brisson's "l'Alouette de Mer," he redescribed the latter as *Tringa cinclus*. Meyer and Wolf's *Tringa variabilis* (1810) made a third designation for the same species, and the vast majority of the Old World references, as listed by Sharpe (1896), Ridgway (1919), and others fall under one or the other of these three names. In view of the seasonal changes to which the species is subject, and which were imperfectly understood in those early days, considerable allowance must be made for this duplication. It was some years before these supposed species were recognized as identical and the later names discarded. In the meantime two additional forms of the group had been described: *Tringa schinzii* by C. L. Brehm (1822) from the shores of the Baltic Sea and *Scolopax sakhalina* by Vieillot (1816) from Sakhalin Island, but the latter was not recognized as pertinent until Buturlin (Auk **21:** 53. 1904) called attention to it. The form *schinzii*, although accepted by many authorities, was discounted by Sharpe (1896), who rightly considered it merely a geographical variant. From the material examined in this connection (11 specimens from Holland and Sweden) it appears to be an easily recognizable race, characterized by its smaller size and heavier breast-streaking as compared with true *alpina*. It breeds in the British Islands and in corresponding latitutdes in Holland and the Baltic Sea countries—far to the southward of the normal range of true *alpina*.

In due course the known range of the species was extended by various American authors, beginning with Wilson in 1813. No distinctions were admitted between the European and American birds until 1858, when Cassin drew attention to the larger size and disproportionately longer bill of the latter, which he thereupon christened *americana*, but without designating a type specimen. The name was accepted by most American writers, although latterly only in a subspecific sense. A few years later (1861) Coues discussed a supposedly larger race from the Pacific coast, which he provisionally named *pacifica*. In 1885 Stejneger pointed out that Cassin's name *americana* was preoccupied, and proposed to replace it by Coues's *pacifica*. He claimed that Coues's type (here designated as no. 9540, collection U. S. National Museum) was "in every essential a true *P. americana* CASSIN," which form was common to "both the Asiatic and American shores of the Pacific Ocean." Stejneger's conclusions were adopted in the American Ornithologists' Union Check-List and were indeed not questioned until 1904, when the Russian ornithologist Buturlin showed that Vieillot's long unrecognized name *Scolopax sakhalina* (1816), from Sakhalin Island, was pertinent to the Pacific form. As a result this name came into general use, nor was it ever challenged until 1914, when Thayer and Bangs insisted that east Siberian birds were not the same as American birds, to which latter they restored the name *pacifica*. The latest authors to discuss the question (Hellmayr and Conover, 1945) fully indorse and emphasize Thayer and Bangs's views. And thus the matter stands at present.

The identification of dunlin specimens he collected in Alaska gave some trouble to A. M. Bailey (Condor **28:** 34. 1926) and to the authorities to whom he sent them for determination. He has generously placed his entire Alaskan series at my disposal. Taking breeding birds alone, I find that there seem to be two forms represented. One of these is a comparatively short-billed bird, with the dusky streaking on the throat and breast subdued or nearly wanting. Of this form there are available 26 breeding specimens from Point Barrow, Wainwright, Chipp River, and Point Hope—all in northern Alaska. The other form, represented by 20 breeding specimens from the rest of Alaska, is longer-billed by comparison, with heavier streaking on the throat and breast. Young birds of the two races in the spotted juvenal dress appear to differ only in the length of the bill.

Through the courtesy of certain other institutions I have been able to compare a fair series of dunlin specimens from Sakhalin Island—topotypes of *sakhalina* of Vieillot—with the northern Alaska series, and I find the two populations racially distinct. As Conover says, the upperparts in Sakhalin birds average lighter-colored—more buffy, less rufescent. Also the black area of the underparts averages more restricted. Compared with *pacifica* the much longer bill, darker upperparts, and more heavily streaked breast of the latter will serve to distinguish breeding specimens of the two forms at a glance. Note that Conover's study did not involve examination of any specimens taken north of Nome; this will account for his failure to discriminate a northern race. As already stated, I have seen no specimens of this race from south of its breeding grounds, but I believe that the relatively shorter bill would serve to distinguish them.

Now we come to consider the dunlin population of the American Arctic east of Alaska. Fortunately we have a fine series of breeding birds from two localities, Churchill on the west coast of Hudson Bay and Southampton Island at its northern end. Even a casual comparison of these with breeding Alaskan birds will show that we are here dealing with a different race. Seasonally comparable Hudson Bay birds are obviously lighter brown above than Alaskan *pacifica*—raw sienna as against antique brown—although the streaking on the throat and breast runs about the same, and their bills average a trifle shorter. Birds taken in spring migration (May) show the same color differences when compared in series, although less markedly. Owing to lack of material I am unable adequately to compare birds in the ventrally spotted juvenal dress, but those I have seen (from Southampton and Churchill) vary greatly in the amount of spotting, while the different stages of postjuvenal molt cause great variation in the color of the upperparts. Judged from the description and measurements in Salomonsen's *Birds of Greenland*, these cannot be referred to *arctica*, since their bills are much too long. This Hudson Bay population is also sufficiently homogeneous and well marked to deserve racial recognition. In North America we should then have three races of the dunlin regularly represented, as follows:

Erolia alpina arcticola, n. subsp.

Type.—No. 8503, collection Carnegie Museum, adult male; Point Barrow, Alaska, June 8, 1898; E. A. McIlhenny.

Subspecific characters.—Similar to *Erolia alpina pacifica* (Coues) of middle and southern Alaska, etc., but bill averaging somewhat shorter (sex for sex); and throat and breast more lightly streaked (sometimes nearly immaculate). Similar also to *E. alpina sakhalina* (Vieillot) of Sakhalin Island and eastern Asia in general, but upperparts darker colored; throat and breast more decidedly streaked; and black abdominal area averaging more extensive.

Measurements.—Adult males in breeding dress: Wing, 113–122 (average, 116.6); bill, 33–35 (33.7); tarsus, 22.5–25 (23.6). Female (8 specimens): Wing, 114–124 (120.5); bill, 34–39.5 (37); tarsus, 24–26 (25).

List of specimens.—Alaska: Point Barrow, 18; Point Hope, 1; Chipp River, 2; Wainwright, 25. Total, 46.

Range.—Northern Alaska in summer; migratory and winter ranges not yet ascertained.

Erolia alpina pacifica (Coues)

[*Pelidna*] *Pacifica* Coues, Proc. Acad. Nat. Sci. Philadelphia, July 1861: 189 (west coast of North America; the type from Simiahmoo, Washington —*cf*. Stejneger, U. S. Nat. Mus. Bull. 29: 121. 1885).

Remarks.—The most distinctive character of this race is its relatively longer bill, which serves to distinguish it in winter dress when the plumage characters are obscured. In breeding plumage it tends to run a little darker above than *arcticola*, while the throat and breast average more heavily streaked. There are available a good series of breeding birds of this race from Wales, Alaska, also some typical specimens from St. Lawrence Island, Bering Sea, and winter and spring birds from the coast farther south. *E. a. pacifica* is of course very different from *sakhalina*, as Conover truly says. His comparisons of the two, be it noted, were made with specimens of undoubted *pacifica* and not of the more northern *arcticola*. There is no evidence that *pacifica* migrates southward along the Siberian coast, although it may do so upon occasion. All the specimens seen from that region appear referable to *sakhalina*, as defined by Conover.

Measurements.—Adult males in breeding dress: Wing, 110–121 (average, 115.5); bill, 35–43 (37.4); tarsus, 22–26.5 (24.7). Female: Wing, 109–120 (118.3); bill, 38–43.5 (41.4); tarsus, 24–27 (25.7).

List of specimens.—Alaska: Wales, 14; Cape Prince of Wales, 2; St. Lawrence Island, Bering Sea, 4. British Colombia: Denman Island, 1. Washington: Simiahmoo (type), 1. Oregon: Bayocean, 3; Newport, 2; Devils Lake, 1; Netarts Bay, 2. California: Mount Eden Landing, 1; San Diego, 8. Lower California: Abreojos Point, 3. Total, 42.

Erolia alpina hudsonia, n. subsp.

Type.—No. 110079, collection Carnegie Museum, adult female; Coral Inlet, Southampton Island, Hudson Bay, Canada, June 6, 1930; George M. Sutton.

Subspecific characters.—Similar in general to *Erolia alpina pacifica* (Coues) of central and southern Alaska and the Pacific coast of America, but general coloration of upperparts richer and brighter; throat and breast more heavily streaked with dusky; and bill averaging slightly shorter.

Range.—From the Mackenzie Delta (presumably) east along the Arctic coast and islands to Baffin Land, and south along Hudson Bay to Churchill; migrating through eastern Canada and the eastern United States to the Gulf coast.

Measurements.—Adult males in breeding plumage: Wing, 113–118 (average, 115.5); bill, 35–38.5 (36); tarsus, 25–27 (25.4). Female: Wing, 114–120 (117); bill, 37–41 (39); tarsus, 25–28 (26.3).

Remarks.—Comparison of our fine series of breeding birds from Hudson Bay and northward shows that they represent a race different from either of the Alaska birds. The brighter coloration of the upperparts and the more heavily streaked throat and breast are constant features when specimens in the same stage of plumage are compared. In winter dress this race may sometimes be distinguished from *pacifica* by the tendency to a shorter bill, but there is so much overlap in this respect that the distinction is far from absolute. It is fair to presume, however, that this is the race that migrates across eastern North America to its winter quarters on the Gulf coast.

List of breeding specimens.—Southampton Island, Hudson Bay: Coral Inlet, 11; Four Rivers, 4; Prairie Point, 4; Fords Brooks, 3. Manitoba: Churchill, 15. Total, 37.

There remain several North American dunlin records which have been referred to true *alpina*, but which according to Hellmayr and Conover (Publ. Field Mus. Nat. Hist., zool. ser., **13** (pt. 1, no. 3); 200, note. 1948) more likely pertain to the Greenland race, *arctica*. In view of the distinctions noted in the present paper, re-examination of these records is indicated.

The writer wishes to thank the institutions that have courteously placed at his disposal their material representing this group: Denver Museum of Natural History (A. M. Bailey); Academy of Natural Sciences of Philadelphia (Rodolphe M. de Schauensee); Museum of Comparative Zoology (J. C. Greenway, Jr.); and United States National Museum (Dr. Herbert Friedmann).

Measurements are based on a series of 10 specimens (unless otherwise specified).

ZOOLOGY.—Postmonorchis donacis, *a new species of monorchid trematode from the Pacific coast, and its life history.*

R. T. YOUNG,[1] University of Montana (emeritus). (Communicated by E. W. Price.)

Hopkins (1941) has described a monorchid trematode in the pigfish (*Orthopristis chrysoptera*) and the spot (*Leiostomus xanthurus*), and Manter (1942) and Hanson (1950) have found the same worm in the grunt (*Haemulon flavolineatum*) although the latter writer questions the identity of the fish which she studied. A trematode of the same genus but a new species has been found by me in several species of surf perches (Embiotocidae), the corvina (*Menticirrhus undulatus*), and spot fin croaker (*Roncador stearnsi*) which I now propose to describe, together with a note on its life history.

The worms were studied mainly in the living condition, but whole mounts fixed in the Dubosq-Brazil modification of Bouin's fluid and in an alcoholic solution of mercuric chloride with a 5-percent addition of acetic acid and stained in acetocarmine and in Ehrlich's hematoxylin have also been employed.

The trematodes were numerous in 1935–36 and again in 1951. No search was made for them in the interim, but the infrequence of their intermediate host, the bean clam (*Donax gouldii*), during this period renders their occurrence then unlikely.

They differ from *P. orthopristis* as follows: Their form is different, being slender rather than rounded and resembling *Genolopa* in this respect. The testis is longer than wide, while the reverse is true in the former, and the posterior notch mentioned by Hopkins is lacking. The vitelline reservoir is inconstant, depending on the state of contraction or expansion of the yolk ducts. The excretory bladder is approximately spherical rather than elongated, while the uterus fills almost the entire posterior body region instead of being restricted mainly to the lateral regions. Black pigment spots are present, either as consolidated "eye" spots or as scattered granules evidently the remains of definite "eye" spots in the larva. The flame cell pattern could not be completely determined. In most specimens the flames were inactive, and in spite of a careful examination several probable cells escaped detection. All that could be seen are shown in Fig. 1. Judged from the close relationship of this worm to *P. orthopristis* it is highly probable if not absolutely certain that the formula is the same as that given by Hopkins for the latter.

Postmonorchis donacis, n. sp.

Slender, elongated worms covered with small spines anteriorly, which gradually disappear near the ventral sucker. Dimensions of fresh specimens, flattened beneath a cover glass: length 0.48 mm; width, 0.207; oral sucker, 0.071; ventral sucker, 0.06; pharynx, 0.048 by 0.031; ovary, 0.037 by 0.031; testis, 0.055 by 0.052; seminal vesicle, 0.105 by 0.095; eggs 0.024 by 0.015. In fixed material the dimensions are as follows: length, 0.336 mm; width 0.07; oral sucker, 0.046; ventral sucker, 0.038; seminal vesicle, 0.059 by 0.0345; ovary, 0.042 by 0.028; testis, 0.047 by 0.033; eggs, 0.021 by 0.012. Pigment spots present. Ventral sucker at about one-third length of body from anterior end. Ceca terminate posterior to anterior end of testis. Vas deferens and metraterm open through a gonopore in the midline just anterior to the ventral sucker. The cirrus sack

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[1] I am indebted to Dr. Carl L. Hubbs, of the Scripps Institution of Oceanography, for the use of an aquarium in the prosecution of this research, and to the San Diego Zoological Society and the U. S. Bureau of Animal Industry for the occupation of rooms in their laboratories. I also had the privilege of spending a few days at the laboratory of the U. S. Fish and Wildlife Service at Beaufort, N. C. To all these my thanks are due. I am indebted too to Edward W. Johnson, of the University of Maryland, for the preparation of the map.

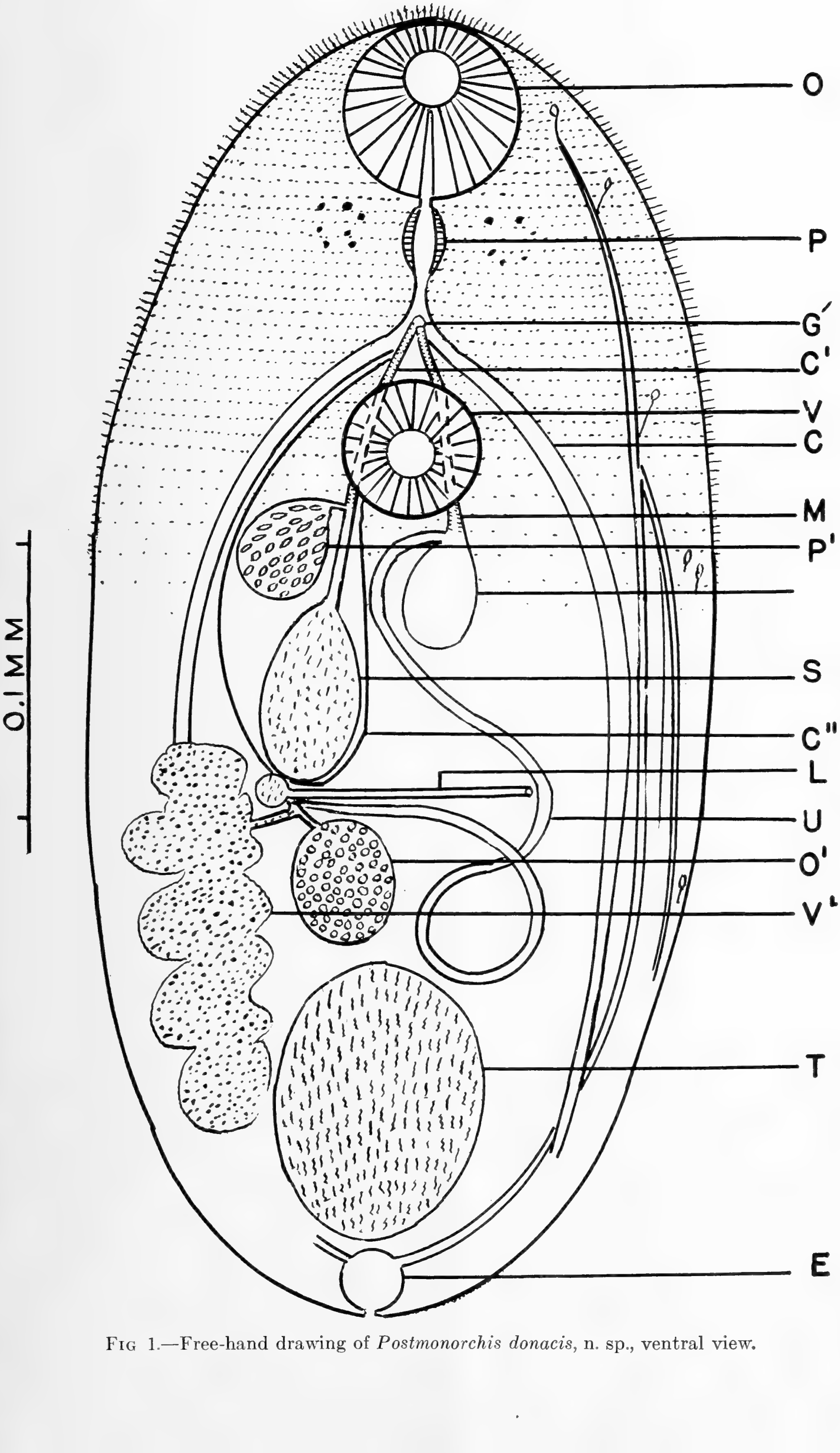

Fig 1.—Free-hand drawing of *Postmonorchis donacis*, n. sp., ventral view.

encloses a heavily spined vas deferens and a distinct prostate gland which joins the latter where it expands into the large seminal vesicle. Metraterm heavily spined anteriorly with a posterior blind sack. Gravid uterus filling almost the entire posterior body and opening into the metraterm at about its mid length. Laurer's canal present. Excretory bladder approximately spherical. Vitellaria dendritic, composed of several lobes on a side, usually extending from the anterior end of the testis to about the middle of the seminal vesicle but occasionally reaching beyond the ventral sucker.

Manter (*l.c.*, p. 350) says of the excretory vesicle in monorchids, "In some genera . . . it is Y-shaped, in others it is I-shaped." No mention of a spherical shape is given. And further, "The seminal vesicle in the Monorchidae is often rudimentary and if present at all is difficult to observe." Regarding the seminal vesicle Manter's statement is at variance with the account and figure (8) given by Hopkins (*l.c.*) for *P. orthopristis* and with my own observations on the present species, while in the latter the excretory bladder differs widely from the accounts of both these authors for the Monorchidae.

Location of the parasite in the gut of the fish.—In the surf perches the worms are found mainly in the rectum though occasionally elsewhere in the gut; in the corvina their distribution is more general. Three possible explanations offer themselves for this distribution in the former: 1, Easier access to oxygen in the rectum; 2, differences in pH between the rectum and other parts of the gut; and 3, chemical differences other than pH between these regions. The first of these is apparently ruled out by the distribution in the corvina. A test of pH in a specimen of *Cymatogaster*, one of the surf perches, made for me at the Scripps Institution showed a difference of one-half to 1 unit of pH between the rectum (5.92) and the rest of the gut from the duodenum to the rectum (6.45–6.90). This difference, however, is not peculiar to the surf perches, tests of the gut of several other species of marine fish made by me showing similar differences.

This leaves the third alternative as the most likely explanation. In a study of the gut of the surf perches (Young and Fox, 1936) the rectum was found to contain a brown or orange-colored pigment derived from the shrimp (*Hippolyte californiensis*), which the fish had been eating at the time. Dr. Fox determined this pigment to be a carotenoid of the xanthophyll series which occurs throughout the gut but is transitory throughout most of the gut, persisting in the rectum for a considerable time, but ultimately disappearing there also when a xanthophyll rich diet is withheld. Apparently the worms find attachment easier in a region which is rich in this pigment than elsewhere. It is not essential however for their attachment and survival as their distribution in the corvina, and occasionally in the surf perches indicates.

In this connection the findings of Nicoll (1913, p. 200) are of much interest. He found *Zoonogenus viridis* "universally in the rectum and in no other part of the intestine . . ." of the sea bream (*Sparus centrodontus*). "The rectal contents . . ., partly from the fact that it feeds largely on Crustacea, are usually of a dull brownish color, but the color of the parasite was much more intensely red."

This similarity in location of two different trematodes in two different species of fish would seem to be more than a mere coincidence.

Larval stages in the clam.—The larvae in the clam occur as sporocysts producing cercariae, which in turn give rise to metaceriae. The size of the sporocysts naturally varies with age, the largest I have seen measuring 0.72 by 0.14 mm in fixed material. The young sporocysts are somewhat motile, changing shape from time to time. When present in large numbers the visceral mass is extensively destroyed, as Martin (1940) found in *Cummingia*, and is yellow in color. The fact that the clam is almost universally infested with metacercariae (see p. 92) in considerable numbers without suffering any apparent harm therefrom renders it likely that either (1) several light infestations succeed one another without serious injury to the host, or (2) the visceral mass is regenerated after partial destruction by the parasite.

The cercaria.—The cercaria is illustrated in Fig. 2. It measures 0.43 mm in length, including the tail, by 0.08 mm in diameter in living specimens. The tail is 0.17 mm long, the oral sucker is 0.045 mm and the ventral sucker 0.039 mm in diameter, the pharynx 0.017 by 0.011 mm. In fixed material the dimensions are as follows: length (including tail) 0.228 mm, diameter 0.042, tail 0.09. There are two eye spots. The anterior half of the body is covered with small spines, while the tail is encircled by numerous rings of overlapping scales which give the appearance of spines.

I could not determine all details of the excretory system. There is a small globular bladder at the base of the tail, with a group of several gland cells anterior to it containing granules which stain in neutral red. From the bladder two excretory ducts extend forward to the region of the oral sucker.

Posterior to the ventral sucker the anlage of the future reproductive organs can be seen.

This cercaria resembles closely *Cercaria myocerca* of Villot (1878) ecxept for a slight difference in the relative length of tail and body. It also resembles *Cercaria cummingiae* of Martin (*l.c.*). Both of these larvae, as well as the present one, infest marine pelecypods, so that in habit as well as structure they appear to be identical. Regarding the latter larva Martin (p. 473) says: "The cercaria has certain characters in common with *Cercaria myocerca*, Villot . . . Both of these larvae have the simple, sac-shaped type of excretory bladder. This seems rather significant since *C. myocerca* is a marine form with a setiferous tail and all other described species of setiferous-tailed marine cercariae have either a Y or U-shaped, or a long tubular excretory bladder. Both species have eye spots. The molluscan host of *C. myocerca* is *Scrobicularia tenuis* which belongs to the same family as *Cummingia*." I regard the present species as identical with *C. cummingiae* which is, to all appearances synonymous with *C. myocerca*.[2]

Regarding the adult worm to which these larvae belong Villot (*l.c.*) considered it to be an amphistome, which, as Dollfus (1925) says, is highly improbable. Martin on the other hand thought it was one of the Allocreadiidae. As will be seen from what follows it is highly probable that the adult worm is a monorchid.

The metacercaria.—The metacercaria can be rather easily excysted by pressure on the cover glass. When removed from the cyst it measures, extended, between 0.3 and 0.4 mm. It is located mainly at the base of the siphons, but occurs also in the gills and the edge of the mantle.

The life history.—It has not been possible to work this out completely. I have shown, as will be seen shortly, that the clam *Donax gouldii* is an intermediate host. But whether this is the only one is uncertain. I have made repeated attempts to infest the clam with eggs from the adult worm but all of them were failures. Many worms containing brown-shelled eggs were teased and put in small vials or beakers with the clams, but no miracidia emerged, nor were sporocysts or cercariae found in the clams so exposed, even when the eggs contained active embryos. Most of these experiments were performed in sea water, but in one, Ringer's solution plus mucous from the gut of an *Embiotoca* was used and in others extracts of the gut of a corvina and an *Embiotoca* were employed. I have also made a few attempts to infest the clams by pipetting eggs between the valves of the shell of four *Donax* but without success.

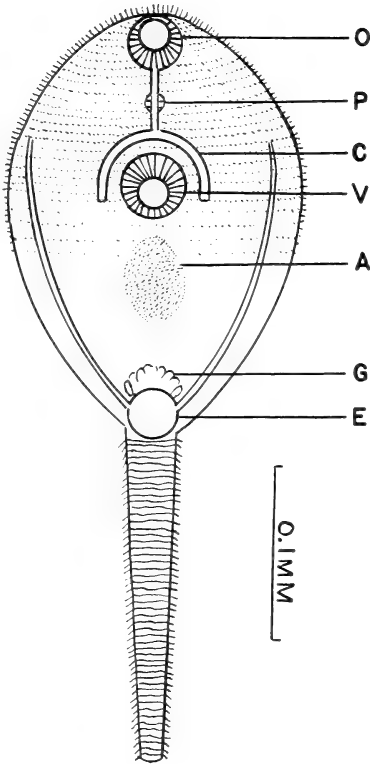

Fig. 2.—Free-hand drawing of the cercaria of *Postmonorchis donacis*, n. sp.

Martin (*l.c.*) has described the life cycle of a related species, *Monorcheides cummingiae*, in the clam, *Cummingia tellinoides* and eels and flounders. He demonstrated the transfer of the parasite from the clam to the fish and postulated its passage in the reverse direction. He also demonstrated the transfer of cercariae from an infested to an uninfested clam, but did not determine

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[2] Should subsequent experiments prove conclusively that *Cercaria donacis* is identical with *C. myocerca* the specific name *donacis* will be superseded by *myocerca*, which has priority. Until such demonstration, however, I prefer to use the new name, *donacis*.

their mode of entrance into the latter, whether through the mouth or the body surface. I have placed active cercariae in dishes with clams but failed to infest the latter. And the cercariae are not attracted by siphons of the clam nor have I seen any of them ingested.

I have, however, found a few cercariae in the clam which lacked tails and were surrounded by a very thin cyst, evidently the first stage of the metacercaria. I have also observed a second stage, intermediate in size between the first and the final stage, which latter is identical with the young worm.

It seems certain that eggs teased out of the worms are not infective. It may be that they require a period of ripening in sea water before becoming so. Martin (*l.c.*), however, found that exposing eggs of *Monorcheides* to sea water for three weeks failed to induce development so that this hypothesis is improbable. It is also possible that a third host is involved in the cycle, perhaps a small copepod which may be ingested by the clam.

The reverse transfer, from clam to fish has succeeded in many experiments, as the following data will show.

A gravid *Embiotoca jacksoni* spawned in an aquarium at the Scripps Institution several days after its capture. The young fish were divided into two lots of seven each, one lot being fed abundantly on *Donax* while the other lot served as controls. One of the experimental fish was found on examination to contain *Postmonorchis* while the controls were all negative. Another of the experimental fish was also infested with small trematodes but the condition of the worms when examined rendered positive identification impossible. It is highly probable that they too were *Postmonorchis.*

Of seven other *Embiotoca* fed *Donax* six proved positive for the parasite, while of 17 controls 14 were negative and three positive. Of 13 *Micrometris* fed *Donax,* 12 proved positive and one negative, while of 44 controls 43 were negative and one positive. In Mission Bay, an arm of the sea near San Diego, *Cymatogaster* breeds abundantly in April and May in the kelp and eel grass which line its shores. There are no *Donax* in the bay and the young perch are apparently never infested. Feeding *Donax* to 24 of these young fishes resulted in infesting 16, while 16 control fish were all negative. That all the experimental fish in these experiments received metacercariae is rendered virtually certain by the fact that of 400 clams examined only five lacked these organisms.

FIG. 3.—Map of the San Diego region, Calif.

I have calculated the significance of these results by a formula in Tippett (1937)

$$\mathrm{T} = \frac{\mathrm{X} - \mathrm{X}'}{\mathrm{S}\sqrt{1/\mathrm{N} + 1/\mathrm{N}'}} \text{ and } \mathrm{S}^2 = \frac{\Sigma(\mathrm{x} - \mathrm{X})^2 + \Sigma(\mathrm{x}' - \mathrm{X}')^2}{\mathrm{N} - 1 + \mathrm{N}' - 1}$$

where X and X' represent the averages of the experimental and the control observations, x and x' the value of each experimental and control observation respectively, and N and N' the number of these observations. Knowing the value of T and the number of observations, both experimental and control, the probability of the result, based solely on chance, can be determined from a table compiled by Dr. George F. McEwen of the Scripps Institution of Oceanography.[3] Applying this formula to the first of the above experiments it becomes $T = (.143 - 0)/S\sqrt{.2857} = 1.1$, where $S = \sqrt{(1 - .143)/12} = .25$, which gives a probability of .1465. That is, there is about one chance in seven that this result might be due to chance alone. Including both of the infested experimental fish in the calculation, which is reasonably justified, the probability becomes 0.044, or about 1 in 25. Making a similar calcula-

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[3] This table is based on one in Fisher's *Statistical methods for research workers* but is more comprehensive.

tion for the other experiments recorded above the probabilities in none of them exceed 1 in 1,000.

The percentage of infested fish from different regions is also significant. *Donax* occurs only on the beaches where it is subjected to wave action and is alternately submerged and exposed by the tides. In both Mission and San Diego Bays (see map) tidal action occurs but wave action is absent, as is *Donax*, while on the beach at La Jolla it is present in vast numbers in certain years. Both of the bays connect with the sea through narrow channels which may serve to isolate their fish from the open sea, at least for considerable periods. Unfortunately I have inadequate data for the same species of fish, but a comparison of different species, all of which serve as hosts for the parasite is of much interest. In 1935 of 26 *Embiotoca* taken at La Jolla all but three were infested, several of them heavily, while of 33 *Micrometris* and 64 *Cymatogaster* from San Diego Bay only one of the former and none of the latter were infested. Many corvina were also taken at La Jolla in this year all but one of which were infested. It is obvious from these results that fish which have access to *Donax* are extensively infested, while those deprived of it seldom are.

BIBLIOGRAPHY

DOLLFUS, R. PH. *Liste critique des cercaires marines à queue sétigère signalées jusqu'à present.* Trav. Stat. Zool. Wimereux **9**: 43–65. 1925.

HANSON, M. L. *Some digenetic trematodes of marine fishes of Bermuda.* Proc. Helminth. Soc. Washington **17**: 74–88. 1950.

HOPKINS, S. H. *New genera and species of the family Monorchidae (Trematod)a with a discussion of the excretory system.* Journ. Parasit. **27**: 395–407. 1941.

MANTER, H. W. *Monorchidae (Trematoda) from fishes of Tortugas, Florida.* Trans. Amer. Micr. Soc. **61**: 349–60. 1942.

MARTIN, W. E. *The life cycle of* Monorcheides cummingiae, *with special reference to its effect on the invertebrate host.* Biol. Bull. **79**: 131–44. 1940.

NICOLL, W. *On two new trematode parasites from British food-fishes.* Parasitology **5**: 197–202. 1913.

TIPPETT, L. H. C. *The methods of statistics.* London, 1937.

VILLOT, F.-C.-A. *Organization et développement de quelques espèces de trématodes endoparasites marins.* Ann. Sci. Nat. Zool., 6e ser., **8**: 40 pp. 1878.

YOUNG, R. T., AND FOX, D. L. *The structure and function of the gut in surf perches (Embiotocidae) with reference to their carotenoid metabolism.* Biol. Bull. **71**: 217–37. 1936.

ABBREVIATIONS USED ON FIGURES

A, reproductive anlage.
C, caecum.
C′, cirrus.
C″, cirrus pouch.
E, excretory bladder.
G, glands.
G′, gonopore.
L, Laurer's canal.
M, metraterm.
O, oral sucker.
O′, ovary.
P, pharynx.
P′, prostate.
S, seminal vesicle.
T, testis.
U, uterus.
V, ventral sucker.
V′, vitellarium.

PROCEEDINGS OF THE ACADEMY

458TH MEETING OF BOARD OF MANAGERS

The 458th meeting of the Board of Managers, held in the library of the Cosmos Club on November 17, 1952, was called to order by President RAMBERG at 8:03 p.m. with the following in attendance: WALTER RAMBERG, H. S. RAPPLEYE, J. A. STEVENSON, W. F. FOSHAG, A. T. MCPHERSON, W. R. WEDEL, SARA E. BRANHAM, W. W. DIEHL, F. M. DEFANDORF, FRANK M. SETZLER, A. G. MCNISH, L. A. SPINDLER, HERBERT G. DORSEY, MARTIN A. MASON, E. H. WALKER, W. N. FENTON, J. R. SWALLEN, and J. P. E. MORRISON.

The President announced the appointments of W. T. READ and N. L. DRAKE to the Science Education Committee.

It was recommended that the Committee on Policy and Planning together with the Executive Committee consider publishing a simplified Red Book, and that it list the Members of the Academy, the Constitution and the Bylaws, and information pertaining to the objectives of the Academy, and that a page be devoted to each of the Affiliated Societies. The hope was expressed that this material can be published early next year.

Chairman MCPHERSON, of the Committee for the Encouragement of Science Talent, presented a report that listed 45 members of professional societies who are now cooperating in the Promotion of Science Talent. This group has been organized to provide effective contact with students through assembly programs in all local private and public junior and senior high schools, at which an engineer or scientist will speak. They will also provide for group conferences with students in cooperation with science supervisors and school principals.

Messrs. McPherson and McNish spoke of the Christmas Lectures to be sponsored by the Philosophical Society for the Washington Junior Academy of Science. The first lecture is scheduled for December 30 on which date Dr. Land, of the Polaroid Corporation, will speak.

The President read the following report of the Nominating Committee:

> The Nominating Committee, consisting of the Vice-Presidents of the Academy, met at the Cosmos Club on Monday, October 27, 1952. The meeting was called to order at 8–15 p.m. by A. G. McNish, who presided. Others present were: Herbert G. Dorsey, John K. Taylor, John A. Stevenson for Lee M. Hutchins, and Arnold H. Scott.
>
> The nominees selected for the offices to be filled by balloting by members in December were as follows: For President-Elect, Francis M. Defandorf; for Secretary, Jason R. Swallen; for Treasurer, Howard S. Rappleye; and for the Board of Managers to serve from January 1953 to January 1956 (two to be elected), Martin A. Mason, Raymond J. Seeger, William T. Read, and Herbert G. Dorsey.

The death on October 13, 1952, of Dr. Paul G. Neal, Director of the U. S. Public Health, was announced.

Senior Editor Foshag reported conversations subsequent to the last meeting with F. N. Frenkiel who thought that four to six articles in mathematics and physics would have to be published in each number of the Journal to build up sufficient interest in the Journal in these fields. Dr. Foshag felt that this would require a large increase in the budget. President Ramberg suggested everything possible be done to maintain and broaden general reading interest and suggested that it might prove attractive to readers if a section were devoted to prompt publication of brief notices of new developments in these fields. The meeting adjourned at 9:55 p.m.

459TH MEETING OF BOARD OF MANAGERS

The 459th meeting of the Board of Managers held in Room 304 of the Cosmos Club on December 15, 1952, was called to order by President Ramberg at 8:03 p.m. with the following in attendance: Walter Ramberg, F. M. Defandorf, H. S. Rappleye, J. A. Stevenson, Frank M. Setzler, C. F. W. Muesebeck, Sara E. Branham, R. G. Bates, Hugh T. O'Neill, John K. Taylor, W. A. Dayton, A. H. Scott, L. A. Spindler, M. A. Mason, E. H. Walker, H. W. Wells, W. N. Fenton, and, by special invitation, J. R. Swallen, L. E. Yocum, Robert G. Duncan, and Lawrence A. Wood.

The Secretary read the following report for the Executive Committee:

> Meeting of the Executive Committee December 12, 1952, attended by Messrs. Dayton, Ramberg, Rappleye, Setzler, and Defandorf. Mr. Dayton, Chairman of the Policy and Planning Committee, reported on the recommendation that his committee offered in answer to the question raised at the May meeting of the Board as to what material newly elected members should receive from the Academy. There was general agreement that newly elected members should receive in addition to the usual letter telling of election and the monthly copies of the Journal, a certificate of membership, a copy of the Academy Bylaws, information on the history and aims of the Academy, information on the Affiliated Societies, and a current listing of Academy members.
>
> After a discussion of detail the Executive Committee was of the opinion that in future Red Books the Academy should list Academy members but should not attempt to include the names of members of its Affiliated Societies. It was felt that in terms of the 50th anniversary issue, the current 1947–48 Red Book now out of print, the next issue could well be reduced in complexity and size.
>
> In brief it was felt that in the future Red Books should contain the following minimum information:
>
> 1. A brief history of the Academy.
> 2. Paragraphs describing how the objectives of the Academy are being met.
> 3. The Academy Bylaws and Standing Rules of the Board of Managers.
> 4. Descriptive material on the Affiliated Societies including a current listing of their officers.
> 5. List of Academy members with addresses, and separate groupings of members in accordance with employment connections.
> 6. Listing of usual meeting-times-and-places of the Affiliated Societies.
>
> A preliminary draft of material for (2) above was presented and it was understood that the Secretary and Treasurer will assemble the other information needed for publication.
>
> It was understood that the Treasurer will obtain estimates as to the cost of printing the Red Book by letterpress and a similar estimate for photo-offset reproduction, looking forward to possible annual publication of the Red Book in the

above simplified form, an edition to be published early next year.

The Executive Committee considers that separate certificates of membership should be issued to each new member and to those active members who did not receive certificates after they were discontinued.

The Executive Committee is hopeful that suitably inexpensive editions of the Red Book and desirable but less expensive membership certificates can be prepared so that they may be retained as annual budget items. Methods of preparation of certificates were discussed and will be investigated as to cost. The treasurer will include these as appropriate items in next year's budget.

There was a discussion of a letter from the National Science Foundation. The Foundation is not in a position to assist financially in the publication of the Index. It was felt that the Academy should proceed without delay to publish the Index. The Committee on Monographs should prepare plans for widely circulating the announcement of publication of the Index, as this should prove helpful in recovering a fair proportion of the total cost through greater purchases by libraries and other nonsubscribers to the JOURNAL.

This report was approved.

Chairman WELLS of the Committee on Meetings mentioned that the following meeting on January 15 was scheduled as the Annual Dinner Meeting of the Academy. It was decided to leave all arrangements in the hands of the Meetings Committee.

Chairman FENTON of the Committee on Monographs reported that he had been in touch with Mr. OEHSER and that the galley proof of the Index has been received. It appears that on a double-column basis the Index will run about 330 to 400 pages.

JASON R. SWALLEN, Chairman of the Committee on Awards for Scientific Achievement, asked the Chairmen of his subcommittees who had been invited to attend this meeting to present nominations for the awards.

Chairman YOCUM of the Grants-in-Aid Committee presented a report filed with the Secretary that recommended a grant of $200 for the purchase of radioactive sodium from the Atomic Energy Commission to EDWARD HACSKAYLO for a mycorrhizal research to be carried out at the Institute of Physiological Research in Uppsala, Sweden, under Dr. Elias Melin, a world authority on this subject. This research will be made in completion of requirements for a Ph.D. degree at George Washington University.

Mr. DAYTON, Chairman of the Policy and Planning Committee, presented a report for his Committee which was filed with the Secretary. It included in addition to the items reported above as being adopted at the meeting of the Executive Committee the following paragraph:

> With regard to finances: There is general agreement among the Committee members that the Academy's finances should be sound and that we should keep out of debt; that our annual income (about 90 percent) should be spent only for definite objectives—such as the JOURNAL, the Junior Academy, appropriate meetings and conferences, and the stimulation and advancement of science in our area—with perhaps 10 percent held as a reserve for contingencies. Majority sentiment is that permanent headquarters with a paid full-time executive secretary is "very far in the future" and should not be considered unless and until justified by the amount of business and income of the Academy.

There was a discussion of the possibility of a paid secretarial arrangement by Messrs. WELLS, DAYTON, and RAPPLEYE that confirmed the conclusion of this Committee.

For the Committee on the Encouragement of Science Talent President RAMBERG reported for A. T. McPHERSON that the announcements of the Christmas Lecture of the Philosophical Society of Washington were being sent to all members of the Washington Junior Academy of Sciences. He reported that up till then a total of $510 had been received from Affiliated and several other Societies in support of the District of Columbia Annual Science Fair.

The Secretary reported the death of Dr. EDWIN F. WENDT on September 30 and of Dr. CHARLES L. G. ANDERSON on December 10, 1952.

The meeting adjourned at 10:00 p.m.

460TH MEETING OF BOARD OF MANAGERS

The 460th meeting of the Board of Managers held in Room 304 of the Cosmos Club on January 12, 1953, was called to order by President RAMBERG at 8:02 p.m. with the following in attendance: WALTER RAMBERG, F. M. SETZLER, F. M. DEFANDORF, H. S. RAPPLEYE, J. A. STEVENSON, W. F. FOSHAG, A. T. McPHERSON, F. W. HOUGH, H. G. DORSEY, SARA E. BRANHAM, W. W. DIEHL, A. G. McNISH, F. W. POOS, A. H. SCOTT, R. S. DILL, L. A. SPINDLER, and, by invitation, E. H. WALKER, H. W. WELLS, J. R. SWALLEN, and J. P. E. MORRISON.

Chairman WELLS of the Committee on Meetings spoke of the final arrangements for the dinner meeting on January 15 at Hotel 2400.

The Secretary expressed the regrets of Chairman DAYTON of the Committee on Policy and Planning that he could not attend the meeting. He reported for the Chairman the receipt of a letter from Past President NATHAN R. SMITH recommending approval of affiliation with the Academy of the Society of Metals. Receipt of this letter completes the unanimous approval by his committee. The Board on the basis of this recommendation instructed the Secretary to forward the required supporting material and ballot for affiliation of the Society of Metals to the membership.

Chairman McPherson of the Committee for the Encouragement of Science Talent reported that members of the Junior Academy had been guests of the Philosophical Society at the first Christmas Lecture of a series of annual lectures. This lecture, by Dr. Edwin H. Land of the Polaroid Corporation, resulted in very favorable comments and constituted an excellent initiation of this project for increasing the interest of youth in science. Twenty teachers have requested applications and examination blanks for the Westinghouse Science Talent Search. This year arrangements have been completed to include in this search the senior high schools in Virginia and Maryland within a radius of 25 miles from Washington, the area encompassing resident members of the Washington Academy. Approval of this arrangement has been received from the Virginia Academy of Sciences; the Maryland Academy is not at present actively participating in this search. Chairman McPherson mentioned that the Society of Chemical Engineers and the Washington Section of the Chemical Society are planning a demonstration lecture in February by Professor Allen of Princeton University. This meeting is designed to promote interest in science on a father-son attendance basis.

Chairman McPherson reported that the Seventh Annual Science Fair will be held at American University with one room devoted to Junior and another to Senior High School science exhibits. It is estimated that the cost of materials incidental to operation of the fair will be $1000, whereas contributions from the affiliated societies and others now total only $540. He requested action by the Board on a contribution by the Academy, and $200 was approved as a logical expenditure by the Board for this purpose.

The Secretary announced the deaths of the following members: Miriam L. Bomhard on December 16, 1952, and Arthur B. Lamb on May 15, 1952.

The Treasurer reported on estimates from the Waverly Press for printing a new abridged form of Red Book. One thousand copies as planned would cost approximately $806; if the Constitution and Bylaws were omitted, the cost would be approximately $720.

Senior Editor Foshag submitted a preliminary report for the year, indicating an approximate unexpended balance of $204.05.

Vice-President McNish outlined the desirability of equipping the Assembly Hall of the Cosmos Club with a better motion-picture projector. It is felt that the project is one for concerted action by the Academy and its affiliated societies. This matter is to be considered as unfinished business for action at the next meeting of the Board of Managers.

The Secretary suggested that the new Policy and Planning Committee give consideration to the affiliation of additional societies that have been suggested. The possibilities for affiliation of other societies have not been reviewed for about seven years.

The formal meeting of the Board adjourned at 9:40 p.m. to partake of refreshments provided by retiring President Ramberg who thanked the Board and his committees for their cooperation.

F. M. Defandorf, *Secretary.*

Officers of the Washington Academy of Sciences

President.......F. M. Setzler, U. S. National Museum
President-elect.......F. M. Defandorf, National Bureau of Standards
Secretary.......Jason R. Swallen, U. S. National Museum
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  Anthropological Society of Washington.......William H. Gilbert
  Biological Society of Washington.......Hugh Thomas O'Neill
  Chemical Society of Washington.......George W. Irving, Jr.
  Entomological Society of Washington.......F. W. Poos
  National Geographic Society.......Alexander Wetmore
  Geological Society of Washington.......A. Nelson Sayre
  Medical Society of the District of Columbia.......Frederick O. Coe
  Columbia Historical Society.......Gilbert Grosvenor
  Botanical Society of Washington.......Harry A. Borthwick
  Washington Section, Society of American Foresters.......George F. Gravatt
  Washington Society of Engineers.......C. A. Betts
  Washington Section, American Institute of Electrical Engineers..Arnold H. Scott
  Washington Section, American Society of Mechanical Engineers
  Richard S. Dill
  Helminthological Society of Washington.......L. A. Spindler
  Washington Branch, Society of American Bacteriologists.......Glenn Slocum
  Washington Post, Society of American Military Engineers.......Floyd W. Hough
  Washington Section, Institute of Radio Engineers.......Herbert Grove Dorsey
  District of Columbia Section, American Society of Civil Engineers
  Martin A. Mason
  District of Columbia Section, Society for Experimental Biology and Medicine
  N. R. Ellis
Elected Members of the Board of Managers:
  To January 1954.......Sara E. Branham, Milton Harris
  To January 1955.......R. G. Bates, W. W. Diehl
  To January 1956.......M. A. Mason, R. J. Seeger
Board of Managers.......All the above officers plus the Senior Editor
Board of Editors and Associate Editors.......[See front cover]
Executive Committee.......F. M. Setzler (chairman), F. M. Defandorf, J. R. Swallen, H. S. Rappleye, W. W. Rubey
Committee on Membership......E. H. Walker (chairman), Myron S. Anderson, Clarence Cottam, C. L. Crist, John Faber, Angus M. Griffin, D. Breese Jones, Frank C. Kracek, Louis R. Maxwell, A. G. McNish, Edward C. Reinhard, Reese I. Sailer, Leo A. Shinn, Francis A. Smith, Heinz Specht, Horace M. Trent, Alfred Weissler
Committee on Meetings.......Watson Davis (chairman), John W. Aldrich, Austin Clark, D. J. Davis
Committee on Monographs (W. N. Fenton, chairman):
  To January 1954.......S. F. Blake, F. C. Kracek
  To January 1955.......W. N. Fenton, Alan Stone
  To January 1956.......G. Arthur Cooper, James I. Hoffman
Committee on Awards for Scientific Achievement (A. V. Astin, general chairman):
  For Biological Sciences......Herbert Friedmann (chairman), Harry A. Borthwick, Sara E. Branham, Ira B. Hansen, Benjamin Schwartz, T. Dale Stewart
  For Engineering Sciences......Samuel Levy (chairman), Michael Goldberg, E. H. Kennard, E. B. Roberts, H. M. Trent, W. A. Wildhack
  For Physical Sciences......G. B. Schubauer (chairman), R. S. Burington, F. C. Kracek, J. A. Sanderson, R. J. Seeger, J. S. Williams
  For Teaching of Science..M. A. Mason (chairman), F. E. Fox, Monroe H. Martin
Committee on Grants-in-aid for Research.......Karl F. Herzfeld (chairman), Herbert N. Eaton, L. E. Yocum
Committee on Policy and Planning:
  To January 1954.......H. B. Collins, W. W. Rubey (chairman)
  To January 1955.......L. W. Parr, F. B. Silsbee
  To January 1956.......E. C. Crittenden, A. Wetmore
Committee on Encouragement of Science Talent (A. T. McPherson, chairman):
  To January 1954.......J. M. Caldwell, W. L. Schmitt
  To January 1955.......A. T. McPherson, W. T. Read
  To January 1956.......Austin Clark, J. H. McMillen
Representative on Council of A. A. A. S........Watson Davis
Committee of Auditors.......Louise M. Russell (chairman), R. S. Dill, J. B. Reeside
Committee of Tellers......C. L. Garner (chairman), L. G. Henbest, Myrna F. Jones

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This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) Short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued monthly. Volumes correspond to calendar years.

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JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

Vol. 43 April 1953 No 4

GENERAL SCIENCE.—*Science in the Department of State.*[1] J. W. Joyce, Deputy Science Adviser, Department of State. (Communicated by Walter Ramberg.)

I am sure that this audience needs no reminder of the vital role that science and technology plays in shaping the affairs of our daily lives. We expect science and technology not only to take a major part in providing most of the material things we associate with modern civilization but also to produce a steadily increasing standard of living. We depend heavily upon science and technology to build strong military forces to safeguard our national security. It is not surprising therefore to find that science is becoming inevitably and inexorably interlinked with the affairs of government. There are many indications of this. We find, for example, that scientists and engineers are to an increasing extent being placed in high positions in government—positions that involve broad policy planning, as distinguished from what might be termed tactical planning. Other evidences are found in the marked increase in federal budget items designated for research and development since the pre-World War II period and in the creation of new agencies and establishments with responsibilities in the field of science since World War II. These include the National Science Foundation, the Interdepartmental Committee for Scientific Research and Development, the Research and Development Board in the Department of Defense, and the Office of the Science Adviser in the Department of State.

This evening I should like to tell you a little more about this last-named organization, outlining some of the factors which led to its establishment, recounting some of its accomplishments to date, and venturing some opinions regarding its future.

The relationship between science and foreign affairs is, perhaps, less apparent than in a number of the more obvious cases just mentioned. E. M. Friedwald, writing in *Impact*, has put it as follows:

> The conduct of foreign affairs has always been a traditional preserve of conservatism. But science is not conservative. This perhaps explains in some measure why science, which has lately infiltrated into so many spheres of government activity, has made so little headway in penetrating into the field of foreign affairs. Few are the embassies and legations which do not have their military, naval, air, commercial, and press attaches; but science attaches of a comparable status could until recently be counted on the fingers of one hand.

In 1947, in an effort to continue the excellent scientific liaison with our British colleagues that had been built up through the war years, the Department of State embarked on what was then considered a rather unusual venture in Foreign Service operations. It placed in the American Embassy in London a small science group, staffed by American scientists of established reputation, each serving for a period ranging from three months to a year or more. This operation proved quite successful, and in all some 12 or more scientists served at various times on this staff, although usually there were not more than two in the Embassy concurrently. While the venture proved reasonably successful, the fact that even greater results were not realized was undoubtedly due to the lack of a formal supporting organization in the Department in Washington. It was only through the very commendable efforts of a small number of individuals in the Depart-

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[1] Address delivered at the annual meeting of the Washington Academy of Sciences on January 15, 1953.

ment who undertook to backstop this operation as more or less extra duties that any effective assistance was extended to the London staff.

THE BERKNER REPORT

In 1949 the Department of State made a series of studies to determine a suitable reorganization plan to bring its structure into conformity with recommendations made by the Hoover Commission. One of the task force groups that dealt with these matters reported that

> The Department is dealing on the one hand with foreign policy matters which have a great effect upon United States scientific policy and on the other hand with international scientific activities which have an impact on foreign policy. These matters are being handled at various points without adequate scientific evaluation. . . .

There followed a recommendation that the Department select a scientist of national reputation to serve as a temporary consultant to determine and made recommendations on, first, the role of the Department in national scientific policy, and second, appropriate organization and staffing required to carry out its responsibilities.

Following the approval of this recommendation, Dr. Lloyd V. Berkner, of the Carnegie Institution of Washington, was appointed as a special consultant to the Department of State in October 1949. He was given the task of examining the whole question of science and foreign relations and of making recommendations concerning the Department's responsibilities in connection therewith. The resulting survey produced the Department of State report *Science and foreign relations,* which was released in May 1950.

The Berkner report, as this publication has since been called, sought to answer two important questions: the first, How can the potentialities of scientific progress be integrated into the formulation of foreign policy and the administration of foreign relations so that the maximum advantage of scientific progress and development can be acquired by all peoples?; the second, How can foreign relations be conducted in such a manner as to create the atmosphere that is essential to effective progress of science and technology? The report went on to recommend that United States foreign relations with respect to science and technology must take on a more positive and active character than had existed in the past. Policy makers must become aware of the scientific implications of their decisions as well as a means of obtaining sound evaluation of these implications.

The entire field of science and foreign relations was clearly too broad in its scope to permit effective exploration in a reasonable time and with available effort. It soon became apparent that a most important part of this whole field was the interchange of unclassified, openly available, scientific information. This, then, was to be the limited objective of the survey—and within this framework could be included exchange of publications and manuscripts, exchange of persons, attendance at international meetings, and similar operations through which scientific and technical information might be exchanged. It was further realized that perhaps the greatest need from the United States' point of view lay in acquiring basic or fundamental scientific information from abroad and, accordingly, this aspect received initially the greatest consideration.

OFFICE OF THE SCIENCE ADVISER AND SCIENCE STAFFS ABROAD

In particular, the report recommended that a small office be established within the Department of State to be designated as the Office of the Science Adviser. It also recommended that small science staffs be established at certain American posts abroad. This report was adopted by the Department, and in February 1951 there came into existence on a formal basis the Office of the Science Adviser, reporting directly to the Under Secretary of State. In June and July of that year science staffs were placed in our missions in Stockholm and Bern, and the London staff, which had been continuing on an ad hoc basis since 1947, was augmented.

In February 1952 a science staff was constituted in Paris, and in August of last year two science advisers were sent to the office of the United States High Commissioner for Germany at Bonn. In the summer of 1952, the staff at Bern was withdrawn temporarily, leaving at the present time science attaches in our missions at London, Stockholm, Paris, and Bonn.

The Office of the Science Adviser in the Department of State serves three functions:

1. It introduces science, through collaboration with Department officers, where it is a factor to be considered in foreign policy formulation and administration. On some occasions it takes the initiative to encourage the Department to give proper consideration to the scientific implications of policies—implications that might otherwise go unrecognized. On other occasions it provides scientific evaluation and advice when requested for the development and effectuation of Department policies. Except for atomic energy matters, the Office of the Science Adviser alone within the Department carries these responsibilities and maintains the necessary science liaison with government agencies, private scientific institutions, industrial laboratories, and individual scientists in this country and, through the science attaches, abroad.

2. It helps to conduct foreign relations for the advancement of science in this country through its familiarity with the objectives and interests of American scientists. As I have already said, our national well-being and security are largely dependent upon our scientific progress. This progress in turn depends mainly upon those results of fundamental scientific research that become available to American scientists from whatever source. As Karl Compton observes, "Our outstanding American genius thus far has not been in scientific discovery, but has been in the combination of what is termed Yankee ingenuity and mass production and distribution . . . When it comes to scientific discovery . . . America is not unique. Its achievements are respectable and its scientific stature has grown very rapidly. I would venture the statement that in the field of science the United States is the equal of any other nation, but this is very far indeed from saying that the United States has a scientific monopoly, or even a scientific majority."

By promoting the international exchange of scientific information, encouraging friendly relations with foreign scientists, helping to coordinate our scientific programs, and generally assisting scientists here and in friendly countries abroad through the conduct of our foreign relations the Department contributes to the advancement of science and therefore to our national well-being and security.

3. It carries out coordinating functions. Thus, the Office of the Science Adviser is responsive to the foreign scientific information needs of government agencies engaged in research, where such needs can be met from openly available sources. It is the central point in the Department for coordinating the foreign scientific activities of other government agencies, such as the National Science Foundation, within the framework of our foreign policy.

Within the missions abroad the science staffs perform much the same functions as does the Office of the Science Adviser within the Department. The attache brings to the attention of the appropriate officers of the mission those scientific matters which should be given consideration. He also acts as adviser to the Chief of Mission and divisions of the mission on matters pertaining to science. In addition, he performs important representational functions.

Essentially then, the Science Adviser and the attaches represent science as far as the State Department and the foreign missions are concerned, and at the same time, represent the State Department in its relations with science in this country and abroad. These functions serve to maintain a desirable closer relationship between foreign relations and science.

RECENT ACCOMPLISHMENTS

During the 20-odd months since the formal establishment of the Office of the Science Adviser a wide variety of problems have been dealt with. Experience has shown that there are indeed few areas within the Department of State that do not at some time or other deal with matters which include scientific aspects. Consider for example the field of traditional Foreign Service reporting. While a 2-man science staff in an embassy abroad cannot in any sense of the word hope to cover all fields of science and technology in a given country, it can be most helpful in meeting a limited number of requests for specific information. These might include progress reports on certain projects prior to publication. In other cases, attaches may encounter items which they believe will be of interest to American science. In all such cases the attache would always first receive permission from the investigator to return the information to this country for distribution to American science.

The immediate postwar period witnessed distressing delays in scientific publication due to shortages of one kind or another, combined with imposing backlogs of manuscripts. Under these circumstances spot reporting took on added significance in expediting the exchange of scientific information. Now, however, publication has caught up, and reporting can therefore be confined to the more or less special cases. Even in these instances the operations are usually directed in such a manner that at the earliest possible moment the source and the end-user can be brought together directly so that normal exchange arrangements can be set up without the Department of State as an intermediary.

In addition to the conventional exchange of printed or manuscript reports, there are the very important kinds of operations which brings scientists into direct personal contact with each other. These include all of the exchange programs involving professors, research investigators, and students, and the attendance at international scientific and technological conferences and congresses.

In the exchange programs, the science attaches in the field have rendered valuable assistance in serving as members of the review boards which make the initial judgment on exchange projects. The Office of the Science Adviser has on numerous occasions helped to plan itineraries for visiting scientists coming from foreign countries. This office has also been able to notify our embassies and missions overseas when American scientists plan trips in those cases where we have been advised of such plans in advance. While, due to limited staffs, it is not possible to offer complete travel and accommodation services for all scientific people going abroad, a certain amount of help can be extended in cases of real emergency.

Another important operation of the science office is in serving as a focal point in the Department for the consideration of official representation at scientific international meetings. This has made it possible to assure the selection of groups of official delegates who are best suited professionally to represent American science at international meetings. There have been in the past unfortunate cases where the selection of candidates was made on the basis of their convenient presence at or near the meeting place at the time of the meeting rather than on scientific qualifications. A greater awareness of the needs of American science has resulted in a modest increase in the financial support given to official delegations to international non-governmental scientific meetings, although it is recognized that additional aid of this kind would be most desirable.

Finally the Office of the Science Adviser and the science attaches overseas have done what they could to be of assistance to the officers in the Department and to consular officers in the field responsible for the administration of the visa laws to the end that the national interests can best be served in those cases which involve scientists.

LIAISON WITH NATIONAL ACADEMY OF SCIENCES–NATIONAL RESEARCH COUNCIL

At this point I should like to acknowledge the great assistance that the National Academy of Sciences–National Research Council has rendered to the Department of State in serving as the contact point with American science outside of government. During the writing of the Berkner report the Academy-Council, at the request of the Department, appointed a liaison member to the special survey group. It also appointed a special committee to critically review the manuscript of the report prior to its publication. The Academy-Council clearly recognized its vital role as intermediary between State and American science in general. To carry out this task, it expanded its facilities to include an Office of International Relations. Through this office the Department receives, for example, recommendations for the selection of official delegations to scientific meetings; it obtains aid in dealing with specific problems through the availability of the services of individual members of the Academy-Council and its various divisions and committees; it makes possible the distribution to American science outside of the government of unclassified scientific information received from science attaches overseas.

RECRUITMENT OF SCIENCE ATTACHES

Now a word as to the staffing pattern that has been followed for the overseas missions. Traditionally, the ground for understanding between scientists has been a mutual recognition and respect for ability and accomplishment. This fact clearly suggested that to be most effective, producing scientists, preeminent in their field, should be selected for the overseas staffs. Such persons can expect to be accepted as colleagues and equals by the foreign scientific communities. The senior science attache in each post should be a man, therefore, combining scientific stature, mature judgment, tact in working with his colleagues and associates, and wherever possible, proficiency in the language of the country to which he is assigned. When one combines these characteristics in one person the result is a man whose services to his university or laboratory may almost be classed as indispensable and who is difficult to obtain even on a temporary basis. Our experience so far has shown that the most likely sources of such people are the universities. This has resulted in the acceptance of a 15-month tenure of duty, since it is usually possible to secure such people for a sabbatical year, with the preceding and succeeding summers. While this length of time is all too short to produce the maximum effectiveness from the overall point of view, we have felt that it is the most reasonable compromise, taking into consideration all of the aspects involved. If a producing scientist remains absent from his laboratory for a period of much more then two to three years, he may well lose touch with his field. This, then, sets the maximum limit as far as the scientist's own interests are concerned.

The whole problem of recruiting science attaches has proved to be a most difficult one during these first months of operation. Quite naturally a producing scientist is extremely hesitant to leave a laboratory for an assignment as a science attache unless he is convinced that he can do a useful job. The very high standards which have been set for science attaches add further to the difficulties of finding people. Nevertheless, the results obtained so far through the selection of such preeminent persons have, it is felt, completely justified the staffing pattern chosen. It is our hope that as the operation continues it will become better known among scientists, and further there will be built up an "alumni" of science attaches who will be willing to return for reassignment during subsequent years. In addition, former science attaches who have found the assignment interesting and profitable can pass the word to their colleagues.

CONCLUSION

In conclusion, I should say that the accomplishments of the Office of the Science Adviser and the overseas staffs have more than justified their existence. Certainly, if work load is any measure of need, this is true. In addition to the day-to-day operations which result in the transmission of specific items of scientific information, and the various other services described, there is, I believe, a much more valuable benefit which, at the moment, may be termed intangible, but which in later years can be extremely productive in terms of concrete results. I refer to the improvement in the traditional understanding between scientists in America and abroad which this operation will engender. In such an atmosphere, we are far more likely to learn promptly from our colleagues in other countries of significant discoveries in science, discoveries which, combined with American initiative and production ability, can add materially to our national welfare and security.

ENGINEERING.—*Dynamic stress-strain curves for mild steel using the tangent modulus procedure.* WILLIAM R. CAMPBELL, National Bureau of Standards. (Communicated by Walter Ramberg.)

In this note the author wishes to report on some dynamic stress-strain curves for mild steel obtained by the tangent modulus procedure. This procedure was described in detail in a paper recently presented before the Society for Experimental Stress Analysis (*1*). Briefly, a long bar is subjected to longitudinal impact, and the strain traveling up the bar is measured directly as a function of time with wire strain gages. The stress can not be measured directly by any means known to the author. It is determined indirectly by integration of the tangent modulus or slope of the stress strain curve. This slope is proportional to the square of the velocity of propagation of the strain considered, as pointed out some years ago by Donnell (*2*) and von Karman (*3*). The velocity of propagation was measured directly by comparing carefully synchronized strain signals from wire strain gages spaced a known distance apart along the bar under impact. It should be noted that the procedure of integration rests on the assumption that only one stress-strain curve applies at the strain rates of the test.

Preliminary tests on copper reported in (*1*) were afflicted with a large scatter, but within this scatter the stress-strain curves under impact coincided with that obtained in the conventional static tensile test. In the meantime the testing technique has been improved and the tests have been extended to mild steel, which differs from copper in having an upper and lower yield point and in showing a peculiar delay in yielding under suddenly applied stress (*4*).

Fig. 1 shows static and dynamic stress-

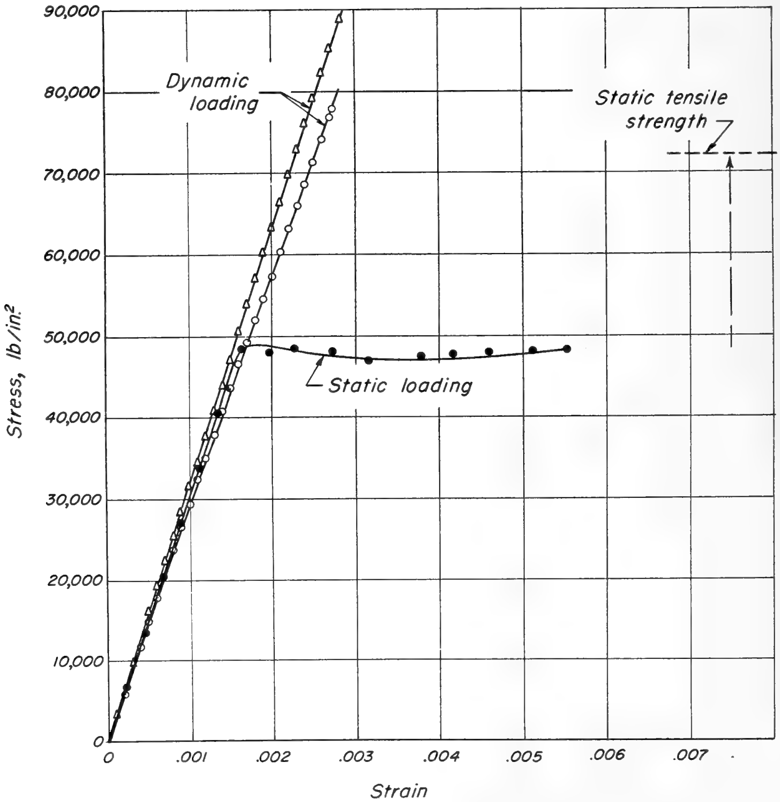


FIG. 1.—Comparison of stress-strain curves for static loading and dynamic loading of mild steel. (Velocity of impact = 57 ft sec. Time to maximum strain = 35 × 10^{-6} sec.)

strain curves obtained by the above procedures for three similar specimens of hot rolled mild steel. Two of the test bars were subjected to longitudinal tensile impact at an impact velocity of 57 ft/sec. Neither bar exhibited any plastic strain for the largest strains recorded or showed any discontinuity in the dynamic curve in the vicinity of the sharply defined static yield point. It is also significant that the maximum stresses generated did not cause failure in in either bar even though these stresses exceeded the static tensile strength.

Obviously, rates of straining of the order of 150 per second applied in the longitudinal impact test have a pronounced effect on the stress-strain curve for mild steel. The shape of the stress strain curve of mild steel beyond the elastic range would be of great interest in view of the importance of this material. It would require not only further tests with impacts of various rise times but also a generalization of the tangent modulus procedure to make it applicable to the determination of the family of stress-strain curves for various strain rates. Such work is being planned in the Engineering Mechanics Section of the National Bureau of Standards.

REFERENCES

(1) Campbell, W. R. *Determination of dynamic stress-strain curves from strain waves in long bars.* Proc. Soc. Exp. Stress Anal. **10** (1). 1952.

(2) Donnell, L. H. *Longitudinal wave transmission and impact.* Trans. Amer. Soc. Mech. Eng. **52** (1). 1930.

(3) Karman, Theodore von. *On the propagation of plastic deformation in solids.* National Defense Research Council Report No. A-29, OSRD 365. Feb. 2, 1942.

(4) Clark, D. S., and Wood, D. S. *The time delay for the iniatation of plastic deformation at rapidly applied constant stress.* Proc. Amer. Soc. Test. Mat. **49**: 717. 1949.

PALEONTOLOGY.—*A new prionodont pelecypod genus.* David Nicol, U. S. National Museum.

In 1944 Olsson (pp. 50–51) described a new species of pelecypod which he named *Cardium* (?) *abnormalis.* The description was based on one left valve from the Upper Cretaceous of the Paita region, Peru. The hinge was not exposed, and the specimen also lacked other diagnostic morphologic characters. Recently Dr. Olsson received two more left valves from Colombia which he gave me to describe. One specimen had a part of the hinge teeth and ligament exposed. Both of these parts of the shell resemble *Glycymeris,* but some other morphologic characters are unusual. After careful preparation and examination, I believe that the specimens represent an undescribed genus.

Pettersia Nicol, n. gen.

Type species.—Cardium (?) *abnormalis* Olsson.

Remarks.—This genus is named for Dr. V. Petters, micropaleontologist for the International Petroleum (Colombia) Ltd., who released two additional left valves for study.

Pettersia abnormalis (Olsson), 1944

Figs. 1–5

Cardium (?) *abnormalis* Olsson, Bull. Amer. Pal. **28** (111): 50–51, pl. 17, fig. 3. 1944.

Description.—Part of Olsson's original description is as follows:

> The shell is of medium size with a *Fragum*-like form and a thick, solid texture; umbo high, wide, ending above in a small prosogyrate beak; umbonal ridge high, angled, the dorsal-posterior area well defined and divided by a groove in the middle, the outer portion being flattened while the inner or side next the hinge is arched or vaulted; a deep furrow or groove extends from the ventral margin upwards towards the beak but is only faintly indicated on the umbo; surface is smooth except for irregularly distributed growth lines which at intervals are grouped together in resting marks; ventral margin crenulated; hinge unknown.

With the two additional left valves given me by Olsson, I can add the following information to the description: The duplivincular ligament consists of five symmetrical chevron-shaped grooves as in *Glycymeris.* The hinge teeth, 34 in number, are symmetrically arranged in an arc on a moderately heavy hinge plate, the side teeth being longer than the central teeth; these teeth are typically like those of a prionodont pelecypod (*Glycymeris, Trigonarca*). The anterior adductor muscle scar is small, situated just below and posterior to the anterior end of the hinge plate; the posterior adductor muscle scar is relatively small, situated on a prominent buttress or flange below the posterior end of the hinge plate. Like the flange or buttress for the posterior adductor muscle of *Cucullaea*, this flange runs anteriorly toward the umbo. The ornamentation consists of small, closely spaced radial ribs which are somewhat beaded. The most characteristic feature is the large sulcus, which runs from the umbonal region to the ventral border. The sulcus is located along the posterior third of the shell. Posterior to the sulcus is a high ridge, and the posterior end of the shell is flattened and truncated. The sulcus is seen in other prionodonts, but it is rarely so prominent on mature specimens. Young specimens of *Cucullaea* and *Anadara* also show this feature. The sulcus is more prominent on species of *Arca*, where it is usually connected with the byssal notch. It is problematical whether *Pettersia* was attached by a byssus, and it will remain so until a specimen of a right valve is examined.

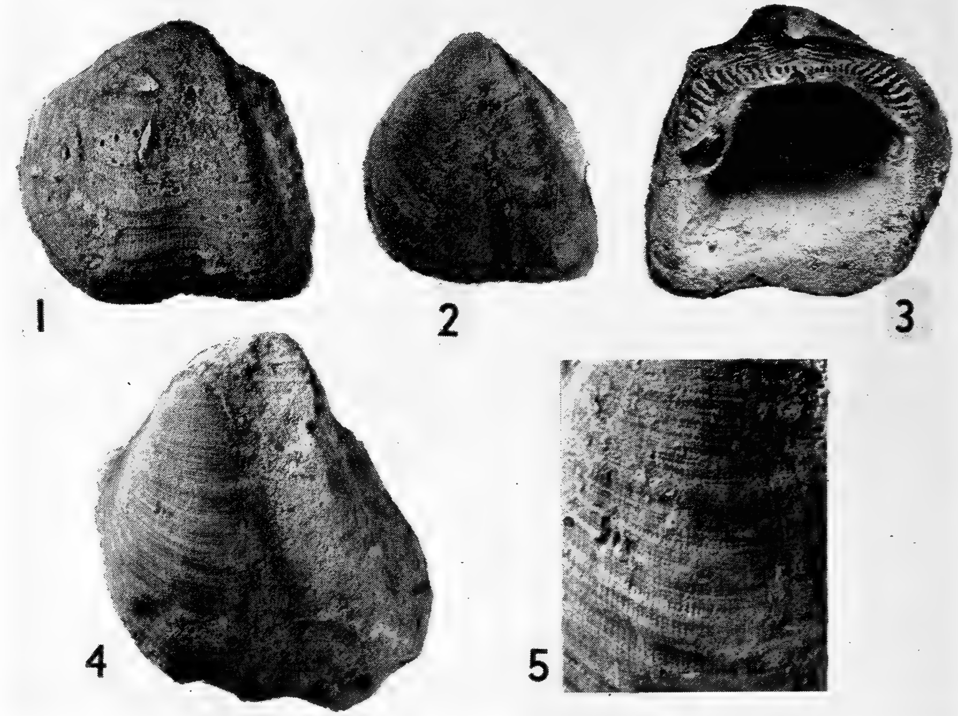
The largest specimen has a high umbo and a tall ligamental area. The beak is located above and at approximately the center of the ligamental area. Olsson states that the beak is prosogyrate, but the material I have examined does not definitely confirm this; it appears to be orthogyrate or, at most, only slightly prosogyrate.

The hinge teeth of *Pettersia* resemble those of *Glycymeris*, *Peruarca*, and *Trigonarca*. The ligament resembles that of *Glycymeris* and *Trigonarca*, and the crenulated margin is similar to that of *Glycymeris*. The buttress for the posterior adductor muscle, the ornamentation, the shape of the shell, and the crenulated ventral margin are like those of many of the Cucullaeidae. However, *Pettersia* differs from these genera in having a very deep sulcus along the posterior third of the shell.

Measurements.—As follows (left valves):

	Height	*Length*	*Convexity*
Holotype, P. R. I. no. 4862	36.0	32.0	17.0
Hypotype, U. S. N. M. no. 108690	40.4	41.8	19.0
Hypotype, Olsson Collection	53.9	48.2	23.7

Locality data.—The holotype came from Tortuga, Paita region, Peru. The hypotypes (personal communication from Olsson) came from



FIGS. 1–5.—*Pettersia abnormalis:* 1, Exterior view, hypotype, U.S.N.M. no. 108690; 2, exterior view, holotype, P.R.I. no. 4862; 3, interior view, same specimen as in Fig. 1; 4, exterior view, hypotype, A. A. Olsson Collection; 5, exterior view showing ornamentation, × 2, same specimen as in Fig. 4. All figures are of left valves. Figures 1–4 are all × 1. Holotype is from Maestrichtian of Paita region, Peru. Hypotypes are from Maestrichtian of upper part of Magdalena Valley, Colombia.

the Upper Magdalena Valley, west side, south of Girardot, 3,300 meters east of El Valle and 7,500 meters north of San Luis, in a small affluent of the Río Luisa, near a house called El Dinde, Tolima Province, Colombia.

Age.—The holotype came from the *Baculites* zone, Maestrichtian stage, Upper Cretaceous. The hypotypes (personal communication from Olsson) were found in a shell bed in a band of sandy limestone 10 meters below a thin ridge of quartz pebble conglomerate. *Pettersia abnormalis* is associated with Foraminifera of the Maestrichtian stage, including *Siphogenerinoides bramlettei* Cushman and Hedberg.

ACKNOWLEDGMENTS

I am particularly indebted to Dr. A. A. Olsson, of Coral Gables, Fla., who sent me specimens for study and asked me to describe the new genus. Dr. Katherine V. W. Palmer kindly allowed me to borrow the holotype of *Cardium* (?) *abnormalis* from the collection at the Paleontological Research Institution, Ithaca, N. Y. Wm. T. Allen, of the U. S. National Museum, made the photographs for the paper.

REFERENCE

Olsson, A. A. *Contributions to the paleontology of northern Peru: Part VII, The Cretaceous of the Paita region.* Bull. Amer. Pal. **28** (111): 146 pp., 17 pls. 1944.

PALEONTOLOGY.—*A new carpoid from Oklahoma.* Harrell L. Strimple, Bartlesville, Okla. (Communicated by Alfred R. Loeblich, Jr.)

The new carpoid described below was found on a field expedition into the Criner Hills of southern Oklahoma made in the spring of 1950 by Mrs. Melba Strimple, Richard Alexander, and the author. An undescribed species of *Archaeocrinus* and *Hybocrinus crinerensis* Strimple and Watkins have been obtained from the same zone.

Myeinocystites, n. gen.

Theca is compressed, slightly convex in midsection of one side, and mildly concave on the opposite side. Following the morphological terminology of Bather (1900), the convex side is considered to be the right side and the apposing to be the left side. In the right side, there are 10 plates forming a marginal rim, or frame, and one is smaller than the others, being located in the extended lower right corner of the theca. Three of the marginal plates adjoin the stem. Within this marginal rim there are three large plates, and one small plate to the lower right. A small cluster of plates, resting in a notch between the two uppermost marginal plates, apparently marks an opening into the body cavity, probably a hydropore.

The left side is more complex. Marginal plates of the right side are curved sharply over to form the frame of the left side. Two additional plates are in contact with the stem, and 19 plates are present within the frame. A single small biserial arm rises in the marginal portion of the oral end of the theca and occupies a groove extending downward. To the left of its proximal extremity is found a long tubelike structure which appears to be an opening into the body cavity, though the function is a matter of conjecture. Immediately above the base of the arm there is a small cluster of plates, previously noted on the right side. A canal originates to the right of the arm base and follows the marginal rim past another opening to the right (probably the anus) and appears to terminate on a convex plate just below midheight of the theca. The proximal portion of the above-mentioned convex plate terminates abruptly, forming a sharp notchlike structure which might represent another opening into the body cavity (? a primitive pore-rhomb). The opening which lies to the right of the arm is covered by seven minute plates which converge toward the center.

The stem is wide, composed of thin columnals which do not form complete circlets owing to interruption by laterally directed sutures on the left side.

Surface ornamentation consists of heavy granules, or minute pustules, which do not form any definite pattern. They are more pronounced on the right side and are entirely absent on the arm, covering plates of the body openings, and in the canal of the left side.

Genotype species.—*Myeinocystites natus*, n. sp.

Occurrence.—Bromide formation, Ordovician; North America.

Remarks.—The presence of a canal is not without precedence among the Anomalocystidae. In *Trochocystites* Barrande (1859) such a canal is reported running round the thecal cavity on the inside of the marginals. Three openings are present in that genus, one in the center of the oral end of the frame (? hydropore and gonopore) and one each to the right and left. Bather (1900) considered one to be the mouth and the other the anus, with question.

Belemnocystites Miller and Gurley (1894) appears to be more comparable to *Myeinocystites* than to other described forms. Unfortunately the specimens available to Miller and Gurley were damaged by silicification and the openings obliterated. Under critical comparison significant differences are readily apparent. The plates of the marginal rim cover an equal portion of both the right (dorsal) and left (ventral) sides in *Belemnocystites*, whereas in *Myeinocystites* only their edges are present on the left side. There are four large plates within the marginal rim of *Belemnocystites* in the right side, and no downward extension of the theca is present. In the present form there are three large plates within the frame, with a fourth, smaller plate in the downward extension of the theca. The plates within the marginals in the left side are more numerous in *Myeinocystites*, which in itself indicates a more primitive form.

Myeinocystites natus, n. sp.

Figs. 1, 2

The theca is compressed, subovoid in outline, 18.3 mm in length by 14.4 mm wide. Midportion of the right side is mildly convex, and the left side is shallowly concave. Ten plates form the marginal rim of the right side, three of which are adjacent to the column. Four plates are present within the marginals. In the left side there are 21 plates within the frame. A single arm is composed of some 24 long, narrow, interlocking brachials and reposes in a groove in the upper portion of the left side of the theca. Just above the base of the arm there is a small pyramid of plates which probably marks an opening into the body cavity (? hydropore). A well-defined opening (? anus) is present to the right of the arm and is connected to the (?) hydropore by a narrow canal which follows the inner edges of the marginals. The canal continues past the (?) anus which opening is covered by seven minute plates. A tubelike extension is present to the left of the proximal tip of the arm, and probably represent an opening into the body cavity.

The entire surface of the theca and column is covered by minute pustules with the exception of the arm, covering plates of the body openings, and the canal. They are more pronounced on the right side and tend to form small spines on the column.

Remarks.—This species is more comparable to *Belemnocystites wetherbyi* Miller and Gurley than to other described forms. Intimate comparison is impossible due to the incomplete preservation of specimens referred to that species; however, some readily discernible differences are noted. Viewed from the right side there are nine plates in the marginal rim (excluding plates in contact with the stem) of *B. wetherbyi*, four to the left and five to the right. In *M. natus* there are only three to the left and five to the right, one of which is a small plate in the downward extension of the theca. There is no extension of the theca in proximal regions, either to the right or left, in *B. wetherbyi*. There are fewer plates, within the frame of *B. wetherbyi*, in the left side than found in the present species.

It is interesting to note that Wetherby, as well as Miller and Gurley, noted the presence of a small node to the left of the arm and surmised the existence of an opening into the body cavity. It is almost certain that the tubelike extension of *M. natus*, which is in that area, represents an opening.

Occurrence.—Bromide formation, Ordovician; bank of Spring Creek, a tributary of Hickory Creek, north of an exposure on Hickory Creek commonly known as "Rock crossing," Criner Hills, southwest of Ardmore, Okla.

Type.—Collected by H. L. Strimple. To be deposited in the U. S. National Museum.

REFERENCES

All cited references are listed in Bassler and Moody, *Bibliographic and faunal index of Paleozoic Pelmatozoan Echinoderms*, Geol. Soc. Amer. Spec. Pap. 45. 1943.

Figs. 1–2.—Holotype of *Myeinocystites natus*, n. gen., n. sp., from right, and left sides, ×2.

BOTANY.—*Critical notes on the genus* Symplocos *in Formosa.*

Hui-Lin Li, Morris Arboretum, University of Pennsylvania.

The genus *Symplocos* is represented by over 20 species in Formosa. Some of the species are important elements of the broad-leaved forests at medium and high altitudes in various parts of the island.

There are two recent works dealing with the genus as occurring in Formosa. Mori, Sylvia **6:** 1–35. 1935, presents a classification of the species based on leaf-characters only, enumerating 34 species. Kanehira's treatment, Formosan Trees, rev. ed. 579–602. 1936, is the most extensive, and in it 30 species are keyed. Most of the species are described and illustrated, but a few inadequately known species are listed by name only.

The works of these and other Japanese authors are based mainly on local material, without adequate reference to the closely related floras of neighboring regions especially the Chinese mainland and the Philippines. Consequently the incidence of endemism, as interpreted by these authors, is considered exceptionally high. For the same reason the nature of some of the widely distributed species is not properly understood, and thus too many species are recognized by slight and trivial variations of little or no taxonomic value.

A critical study of the Formosan species was made with the aid of large reference collections of Asiatic plants in the herbarium of the U. S. National Museum, Smithsonian Institution, representing all the neighboring floras of Formosa, especially the closely related ones of the Chinese mainland, Hainan Island, the Liukiu Islands, the Philippine Islands, and Japan. As a result, it is revealed that many of the widespread species of eastern Asia, particularly those of the Chinese mainland, extend also to Formosa. Many species are found to be not endemic to the Formosan flora but only synonyms of these species of wide ranges. The many duplicate synonyms also prove that fewer species are actually to be found in Formosa. These taxonomic notes are herein presented. Cited specimens are selected from the U. S. National Museum (indicated by US), the herbarium of the National Taiwan University, Formosa (indicated by NTU), and the herbarium of the Taiwan Forestry Institute (indicated by TFI).

1. **Symplocos caudata** Wall. List no. 4413. 1830, nomen; A. DC. in DC. Prodr. **8:** 256. 1844.
  Symplocos prunifolia Sieb. & Zucc. in Abh. Akad. Wiss. Muench. **4**(3): 133. 1846.
  Symplocos sasakii Hay. Icon. Pl. Formos. **5:** 114. *f. 36*. 1915; Mori in Sylvia **6:** 27. *f. 27*. 1935; Kanehira, Formos. Trees, rev. ed. 598. *f. 555*. 1936. *Syn. nov.*
  Symplocos somai Hay. Icon. Pl. Formos. **9:** 69. 1920; Mori in *op. cit.* 28. *f. 28*; Kanehira, *op. cit.* 599. *f. 556*. *Syn. nov.*
  Symplocos sozanensis Hay. *op. cit.* **9:** 70. 1920; Mori in *op. cit.* 28. *f. 29*; Kanehira, *op. cit.* 599. *f. 600*. *Syn. nov.*
  Bobua sasakii Kanehira & Sasaki in Sasaki, List Pl. Formos. 332. 1928. *Syn. nov.*
  Bobua somai Kanehira & Sasaki in *loc. cit.* *Syn. nov.*
  Bobua sozanensis Kanehira & Sasaki in *loc. cit.* *Syn. nov.*

Common and widespread in eastern Asia, from the Himalayas eastward to Japan; Formosa common in forests throughout the island.

Formosa: Mount Syabozan, Taihoku-syu, *G. Masamune 2762* (NTU); Zyukirin, Sinitiku, *Soma 19770* (isotype of *S. somai* Hay. TFI, photo US); Sozan, *Simada 19773* (isotype of *S. sozanensis* Hay. TFI, photo US).

The reduction of the three species of Hayata to this widespread and common species of eastern Asia is based on type specimens as well as the original descriptions.

2. **Symplocos cochinchinensis** (Lour.) Moore in Journ. Bot. **52:** 148. 1914.
  Dicalyx cochinchinensis Lour. Fl. Cochin. 663. 1790.
  Symplocos ferruginifolia Kanehira in Trans. Nat. Hist. Soc. Formos. **20:** 383. 1930, Formos. Trees, rev. ed. 585. *f. 542*. 1936. *Syn. nov.*

Southern China and Indo-china; Formosa, northern part of the island.

I have seen no isotype of Kanehira's species, but his detailed descriptions and illustration clearly indicate the identity of his species with the widespread *S. cochinchinensis* of the mainland.

3. **Symplocos congesta** Benth. Fl. Hongk. 211. 1861.
  Symplocos adinandrifolia Hay. Icon. Pl. Formos.

5: 93. 1915; Mori in Sylvia **6:** 16. *f. 1.* 1935; Kanehira, Formos. Trees, rev. ed. 579. *f. 537.* 1936. *Syn. nov.*
Symplocos adinandrifolia var. *theifolia* Hay. *op. cit.* 95. *f. 24. Syn. nov.*
Symplocos nakaii Hay *op. cit.* 110. *f. 25e. Syn. nov.*
Symplocos phaeophylla Hay. *op. cit.* 111. *f. 34.* Mori in *op. cit.* 26. *f. 25.* Kanehira, *op. cit.* 739. *Syn. nov.*
Symplocos hayatae Mori in Trans. Nat. Hist. Soc. Formos. **24:** 193. 1934; in Sylvia **6:** 21. *f. 12.* 1935. *Syn. nov.*
Symplocos kudoi Mori in Trans. Nat. Hist. Soc. Formos. **24:** 193. 1934; in Sylvia **6:** 24. *f. 18.* 1935; Kanehira, Formos. Trees, rev. ed. 594. 1936. *Syn. nov.*
Bobua adinandrifolia Kanehira & Sasaki in Sasaki, List. Pl. Formos. 330. 1928. *Syn. nov.*
Bobua nakaii Kanehira & Sasaki in *op. cit.* 331. *Syn. nov.*
Bobua theifolia Kanehira & Sasaki in *op. cit.* 332. *Syn. nov.*
Bobua phaeophylla Kanehira & Sasaki in *op. cit.* 332. *Syn. nov.*
Symplocos prunifolia sensu Hay. in Journ. Coll. Sci. Tokyo **30**(1): 188. 1911 (Mat. Fl. Formos.), non Sieb. & Zucc.
Symplocos theifolia sensu Hay., Icon. Pl. Formos. **6:** 29. 1916, non D. Don.

Widely distributed in southern China; Formosa, common in forests, central to southern part of the island.

Formosa: Rengechi, Taityu, *S. Hibino & S. Suzuki*, July 18, 1930 (NTU); Central Range, *Mori 19755* (isotype of *S. adinandrifolia* Hay. TFI, photo US).

Several of the above mentioned names such as *S. nakaii* Hay. and *S. hayatai* Mori, were reduced to the synonymy of *S. adinandrifolia* by Kanehira and others. *Symplocos kudoi* Mori is known only from the type from central Formosa. *Symplocos phaeophylla* Hay. is based on a Kanehira collection of unknown locality. The specimens have not been seen. Judged from the original descriptions and illustrations, these two names, together with *A. adinandrifolia*, all belong to *S. congesta*, a species of wide occurrence on the China mainland.

4. **Symplocos lancifolia** Sieb. & Zucc. in Abh. Akad. Wiss. Muench. **4**(3): 133. 1846.
Symplocos arisanensis Hay. in Journ. Coll. Sci. Tokyo **30**(1): 187. 1911 (Mat. Fl. Formos.); Icon. Pl. Formos. **2:** 120. *f. 19.* 1912; Mori in Sylvia **6:** 17. *f. 2.* 1935; Kanehira, Formos. Trees, rev. ed. 582. *f. 538.* 1936. *Syn. nov.*
Symplocos suishanensis Hay. Icon. Pl. Formos. **5:** 116. *f. 39.* 1915; Mori in *op. cit.* 29. *f. 30.* 1935; Kanehira, *op. cit.* 601. 1936. *Syn. nov.*
Bobua arisanensis Kanehira & Sasaki in Sasaki, List. Pl. Formos. 330. 1928. *Syn. nov.*

Southern China to Japan; in Formosa, at high altitudes in the central ranges.

Formosa: Mount Taheizan, *S. Suzuki*, Aug. 4, 1928 (NTU); *E. H. Wilson 10173* (US), *10222* (US); Arisan, *E. H. Wilson 9715* (US); Arisan, *Kawakami & Mori 19653* (isotype of *S. arisanensis* Hay. TFI, photo US); Arisan, Suisyaryo, *Hayata, Kanehira & Tanaka 19783* (isotype of *S. suishanensis* Hay. TFI, photo US).

Type specimens and descriptions as well as illustrations have shown that Hayata's two species are undoubtedly the same as *Symplocos congestus* Benth., widespread from southern China to Japan.

5. **Symplocos laurina** Wall. List no. 4416. 1830.
Symplocos wikstroemifolia Hay. Icon. Pl. Formos. **5:** 119. *f. 25b.* 1915; Mori in Sylvia **6:** 30 *f. 34.* 1935; Kanehira, Formos. Trees, 602. *f. 506.* 1936. *Syn. nov.*

India to western and southern China; Formosa, in forests, central and southern parts.

Formosa: Mount Taiheizan, *S. Suzuki*, April 1, 1928 (NTU), *E. H. Wilson 12024* (US); Mt. Hassen, Taityu, *Sasaki 19804* (photo, US).

Reduction of *S. wikstroemifolia* is based on the original description.

6. **Symplocos modesta** Brand in Engl. Pflanzenr. **6**(IV. 242): 66. 1901; Hay. Icon. Pl. Formos. **2:** 120. *f. 20.* 1912; Mori in Sylvia **6:** 25. *f. 21.* 1926; Kanehira, Formos. Trees, rev. ed. 595. *f. 551.* 1936.
Symplocos eriostroma Hay. Icon. Pl. Formos. **5:** 99. *f. 25, c.* 1915; Mori in *op. cit.* 19. *f. 8.* 1925; Kanehira, *op. cit.* 583. 1936. *Syn. nov.*
Bobua modesta Yamamoto, Suppl. Icon. Pl. Formos. **4:** 19. 1928.
Bobua eriostroma Kanehira & Sasaki in Sasaki, List. Pl. Formos. 330. 1928. *Syn. nov.*
Symplocos myrtacea sensu Matsum. & Hay. in Journ. Coll. Sci. Tokyo **22:** 230. 1906 (Enum. Pl. Formos.) non Sieb. & Zucc.

Endemic, in broad-leaved forests at high altitudes.

Formosa: Arisan, *E. H. Wilson 9648* (US), *G. Nakahara*, Nov. 1906 (US); Mount Noko, *H. H. Bartlett 6180* (US); Taririku-syu, Taito, *S. Sasaki 19739* (photo US).

Symplocos eriostroma Hay., based on young flowering specimens collected by Sasaki from Arisan, is reduced to *S. modesta* on the basis of the original description.

7. **Symplocos mollifolia** Dunn in Kew Bull. Add. Ser. **10:** 163. 1912.
Symplocos trichoclada Hay. Icon. Pl. Formos. **5:**

118. *f. 25.* 1915; Mori in Sylvia **6**: 30. *f. 32.* 1935; Kanehira, Formos. Trees, rev. ed. 601. *f. 559.* 1936. *Syn. nov.*
Bobua trichoclada Kanehira & Sasaki in Sasaki, List. Pl. Formos. 332. 1928. *Syn. nov.*
Symplocos trichoclada var. *koshunensis* Mori in Trans. Nat. Hist. Soc. Formos. **24**: 195. 1934, in Sylvia **6**: 30. *f. 33.* 1935. *Syn. nov.*

Southern China: Formosa, mountains in central and southern parts.

Formosa: Central Range, *Kawakami & Sasaki 19801* (isotype, TFI).

The type specimen and the original descriptions show that this Formosan plant is conspecific with *S. mollifolia* Dunn., a characteristic species from southern China.

8. **Symplocos patens** Presl. Rel. Haenk. **2**: 61. 1830.
Symplocos kotoensis Hay. Icon. Pl. Formos. **5**: 106. *f. 31.* 1915; Mori in Sylvia **6**: 23. *f. 17.* 1935; Kanehira, Formos. Trees, rev. ed. 593. *f. 584.* 1936. *Syn. nov.*
Bobua kotoensis Yamamoto, Suppl. Icon. Pl. Formos. **4**: 19. 1928. *Syn. nov.*

Luzon; Botel Tobago.

Formosa: Botel Tobago, *Kawakami & Sasaki 19719* (isotype of *S. kotoensis* Hay. TFI).

The type specimen of Hayata's species and his description and illustration clearly prove this to be conspecific with the Philippine species, *S. patens,* of the primary forests of Luzon.

9. **Symplocos setchuensis** Brand in Bot. Jahrb. **29**: 528. 1900.
Symplocos ilicifolia Hay. Icon. Pl. Formos. **5**: 102. *f. 29.* 1915; Mori in Sylvia **6**: 22. *f. 14.* 1935; Kanehira, Formos. Trees, rev. ed. 589. *f. 546.* 1936. *Syn. nov.*
Bobua ilicifolia Kanehira & Sasaki in Sasaki, List. Pl. Formos. 331. 1928. *Syn. nov.*

Widely distributed from western to central China; Formosa, in northern part of the island.

Formosa: Mount Hakko-zan, Toyen, *Mori 19702* (isotype, TFI).

Symplocos ilicifolia is known from a single collection in Formosa. This proves to be the same as *S. setchuensis* Brand of the mainland.

10. **Symplocos stellaris** Brand in Bot. Jahrb. **29**: 528. 1900.
Symplocos eriobotryaefolia Hay. Icon. Pl. Formos. **5**: 98. *f. 10.* 1915; Mori in Sylvia **6**: 19. *f. 7.* 1935; Kanehira, Formos. Trees, rev. ed. 584. *f. 541.* 1936. *Syn. nov.*
Bobua eriobotryaefolia Kanehira & Sasaki in Sasaki, List. Pl. Formos. 330. 1928. *Syn. nov.*

Widely distributed in central and southern China; Formosa, in forests at relatively high altitudes.

Formosa: Mount Daibu, Takao, *E. Matuda s. n.* (NTU).

This species is very close to *S. glauca* (Thunb.) Koidz., but is readily distinguished by the lamellate pith and the glandular-haired petals. The Formosan plant, showing also these distinctive characteristics, is in all respects identical with the species of wide occurrence on the mainland.

11. **Symplocos theophrastaefolia** Sieb. & Zucc. in Abh. Akad. Wiss. Muench. **4**(3): 134. 1846; Mori in Sylvia **6**: 29. *f. 31.* 1935; Kanehira, Formos. Trees, rev. ed. 601. *f. 558.* 1936.
Symplocos stenostachys Hay. Icon. Pl. Formos. **5**: 115. 1915.

China to Japan; Formosa, in broad-leaved forests, from low to high altitudes.

Van Steenis, in Bull. Bot. Gard. Buitenz. III. **17**: 432. 1948, considers *S. stenostachys* Hay. a synonym of *S. confusa* Brand. *Symplocos stenostachys,* described as having a long spicate inflorescence, is very distinct from *S. confusa* and has been correctly referred to the synonymy of *S. theophrastaefolia* Sieb. & Zucc. by Mori, Kanehira, and others.

ENTOMOLOGY.—*American species of* Ranatra annulipes *Stål group* (*Hemiptera: Ranatridae*). Carl J. Drake, Iowa State College, Ames, Iowa, and José A. DeCarlo, Museo Científico Natural, Buenos Aires, Argentina.

Almost a century ago the eminent Swedish hemipterist Carl Stål (1854, p. 241) very briefly described a new species of water-scorpion of the genus *Ranatra* Fabricius from Brazil under the scientific name *annulipes.* Seven years later (1861, p. 204) he redefined the species from the type and somewhat amplified his original description. In the latter article the length of the body and that of the respiratory filaments are given as equal. The characters employed in both descriptions are of little specific value in the separation of species.

After a lapse of nearly 50 years, the renowned aquatic hemipterist A. Montandon (1905, pp. 393–395) of Rumania redescribed at considerable length the male type of *R. annulipes*, which was communicated to him by the director of the Stockholm Museum. Among the more important characters mentioned Montandon pointed out that the metasternum was very strongly developed, very highly elevated, longly narrowly produced posteriorly, and then terminated in an almost vertical curve between the hind pair of coxae. And from a lateral aspect, he also observed that the extremity of the last abdominal segment in the male was very strongly produced downward on each side so as to embrace the apex of the genital operculum. In the same article Montandon also determined as *R. annulipes* several specimens of water-scorpions from the widely separated regions of Novo Friburgo, Isthmus of Darien, Guadeloupe, and Jamaica. From the last three localities the writers have examined specimens bearing identification labels "*Ranatra annulipes* Stål" in Montandon's own handwriting. The specimens from each of the localities represented a different and an undescribed species.

In other papers Montandon (1907, p. 58; 1910a, p. 3; 1910b, p. 185), after studying the types (male and female) of *Ranatra fabricii* Guérin-Méneville from Cuba in the Museum of Zoology of the University of Naples, Italy, incorrectly synonymized this insect with *R. annulipes*. An examination of some Cuban material, determined and labeled by Montandon as *R. annulipes*, revealed that *R. fabricii* was a different species and readily distinguishable from the true *R. annulipes* from Brazil. On this account the writers are resurrecting *R. fabricii* and are treating it herein on the species level. Despite this confusion in differentiating species, Montandon (1907, p. 59) recognized and characterized a very distinct and closely allied species from Ecuador as *R. camposi*. In the same paper Montandon (1907, p. 58) also wrongly named a complex of several species from Panama, Colombia, Mexico, Guadeloupe, and Cuba as *R. annulipes*—none of which included the true *annulipes*.

Since the publication of the original description of *R. annulipes*, the literature is replete with numerous species wrongly named and confused with this insect. Besides *R. fabricii* and *R. ecuadoriensis* De Carlo, four of the five new species described and illustrated in this paper have been confounded in the literature with *R. annulipes*. Thus for several decades aquatic hemipterists have been lumping and confusing in the literature several unnamed species with similar general categories as described for *R. annulipes* under that specific name. From a general aspect, all these species possess similar facies and likenesses in the general appearance of certain structures such as (1) a very high, narrow, and strongly developed metaxyphus in both sexes, (2) large antennae, and (3) the extremity of the last abdominal segment in the male strongly produced downwards on each side in the side in the form of a large toothlike structure (Fig. 11) so as to embrace narrowly the entire apex of the genital operculum. The front femora are without apical tooth or marked sinuosity, and the premedian tooth on inferior edge is fairly large and prominent. The opercula of the females are similar in general appearance and at most only slightly surpass the extremity of the abdomen; the deep thick fringe of stiff, long, reclining, brownish hairs on the underedge of each side of the genital segment is also quite pronounced. As these striking features are shared by a number of American species of the genus *Ranatra*, the structures should be regarded in a general way as "group" characters, which clearly set the members of the *annulipes group* apart from the rest of the species of the genus. Although of similar general appearance, the metaxyphus, anterior femora, and antennae also provide good differential characters of specific importance in this distinctive group of species.

The salient characters by which the species forming the *annulipes group* may be separated from one another include such structures as (1) form and size of body, (2) shape of antennae, (3) shape of anterior femora, (4) size and form of metaxyphus, and (5) shape of male parameres. The illustrations in the text portray the discriminating differences in the antennae, anterior femora, and male parameres of the species.

The species as listed by Kirkaldy (1899, p. 29) from Jamaica and by Hungerford (1936, p. 149) from Yucatán, Mexico, are described herein as new to science. The specimens determined by Montandon (1907, p. 58) as *annulipes* from Colombia, Mexico, and other places represent a composite group of several allied species—all of which are members of the *annulipes* group. The geographics of *R. annulipes* as compiled by Bueno (1906, p. 58) and by Kirkaldy and Bueno (1909, p. 203) represent an aggregate of locality records of several different species. It is thus patent that a large number of the references in the literature to *R. annulipes* refer only in part or not at all to that species, but to complexes of one or more species confused with it, thus invalidating most of the published distributional record for *R. annulipes*.

The tropical and subtropical nature of the members of the *annulipes* group is clearly indicated by the dispersal data of the new and described species. As most of the known records are based largely upon type localities, the species are undoubtedly much more widely dispersed than indicated under the descriptions. Apparently, the *annulipes* group of species occurs only in the Americas.

De Carlo (1950, p. 526) was the first to recognize and separate the true *R. annulipes* Stål of Brazil from its closely related allies. In the foregoing article, he characterized both sexes (female theretofore unknown) and also described a new species of the group from Guayaquil, Ecuador. In his comprehensive work on South American Ranatridae, De Carlo (1946, pp. 14–16) had confused the Ecuadorian species with Stål's *annulipes*. These two papers by De Carlo contain detailed descriptions and many excellent illustrations of the ranatrids of South America.

In order to facilitate future work and to straighten out part of the confusion in the literature, a bibliography is given under the headings of the various species. If a citation includes more than one species, the word *part* is italicized and inserted in parentheses at the end of the reference.

The disposition of the types is given just beneath the description of each new species.

Unless stated otherwise, specimens of the described species are in the collections of the authors. The illustrations of *Ranatra annulipes* Stål and *R. zeteki*, n. sp., were made from the types (except *R. fabricii*) by Mrs. Richard Froeschner and the rest by José A. De Carlo.

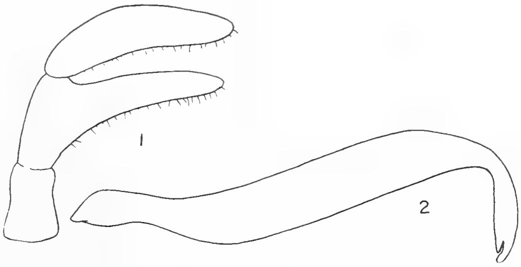
Ranatra annulipes Stål (Figs. 1–2)

1854. *Ranatra annulipes* Stål, Ofv. Vet.-Akad. Forh. **11**: 241.
1861. *Ranatra annulipes* Stål, Ofv. Vet.-Akad. Forh., no. 4: 204.
1905. *Ranatra annulipes* Montandon, Bull. Soc. Sci. Bucharest **14** (3–4): 393–395 (*part*).
1907. *Ranatra annulipes* Montandon, Ann. Soc. Ent. France **76**: 58 (*part*).
1946. *Ranatra annulipes* De Carlo, An. Mus. Arg. Cien. Nat. **42**: 14 (*part*).
1950. *Ranatra annulipes* De Carlo, Rev. Bras. Biol. **10** (4): 526, figs. 14–18.

The following notes are based solely on the male type of *R. annulipes* Stål in the Naturhistoriska Riksmuseum, Stockholm (type kindly lent by Dr. René Malaise).

The type (male) bears labels as follows: (1) "Brasil Oscar", (2) "typus" (red label), (3) "*Ranatra annulipes*" (in Stål's handwriting), and (4) "193" (on a pink label). The specimen, pinned with a large white pin, is in a fair state of preservation. The forelegs are represented by coxae, and the middle and hind legs are entirely wanting. The respiratory appendages are broken (apical part gone) with bases glued on the upper extremity of the last abdominal segment. The hemelytra and wings are partly opened, but otherwise the specimen is in a fairly good state of preservation. The body is in good condition with antennae and parameres fully exposed. Length of male type, 30.00 mm.

Head.—Width across eyes, 3.00 mm. Eyes large, each as wide as interocular space (20:20). Interocular space moderately convex, finely trans-



Figs. 1, 2.—*Ranatra annulipes* Stål: 1, Antenna; 2, left male paramere.

versely rugulose; jugae long, testaceous, scarcely more elevated than tylus, very feebly bowed outward. Rostrum testaceous with apical segment fuscous. Antennae as in Fig. 1.

Prothorax.—Greatest length (measured on pleuron), 9.60 mm. Pronotum with median length, 8.10 mm; width at apex, 2.25 mm; at narrowest place, 1.22 mm; at widest part of hind lobe (near base), 3.20 mm; front part scarcely more than twice as long as hind part (measured on median line) (56:25). Median part of prosternum between shallow lateral sulci gradually more elevated anteriorly, distinctly tectiform in front. Scutellum with front part a little transversely rugulose, impressed on each side near the middle so as to leave between the two impressions a distinct median carina, pitted in the impressed areas; posterior part slightly convex, without distinct striae. Hemelytra extending on base of genital segment. Abdomen (measured on median line), 18.00 mm long; tergites (save last one) reddish, the connexiva yellowish brown. Parameres as in Fig. 2.

Note.—For a detailed description of both sexes with illustrations of important structures, see De Carlo (1950). It should be noted that the prosternum between the shallow sulci is slowly raised anteriorly and quite tectiform in front. The writers have examined the type and three other specimens of *R. annulipes* from Brasil. The left antenna and left paramere of the type are figured; note especially the shape of the paramere.

Ranatra fabricii Guérin-Méneville (Figs. 3–5)

1857. *Ranatra fabricii* Guérin-Méneville, Sagra's Nat. Hist. Cuba **7** (2): 176.

1908. *Ranatra fabricii* Kirkaldy and Bueno, Proc. Ent. Soc. Washington **10:** 203 (*part*).

1910a. *Ranatra annulipes* Montandon, Ann. Mus. Zool. Della R. Univ. Napoli **3** (n.s.): 3.

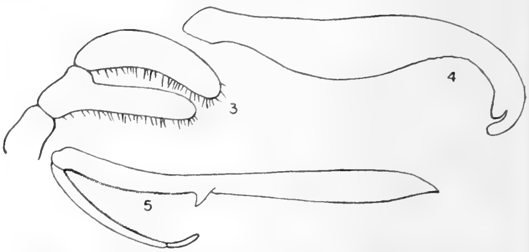
1910b. *Ranatra annulipes* Montandon, Bull. Soc. Sci. Bucharest **28** (5–6): 185 (*part*).

1917. *Ranatra annulipes* Van Duzee, Cat. Hemip.: 463 (*part*).

1922. *Ranatra annulipes* Hungerford, Bull. Univ. Kansas **14:** (17): 446 (*part*).

Redescription (male and female).—Body little robust, moderately long, the respiratory tubes usually a little longer than body.

Eyes large, the width of an eye scarcely greater than width of interocular space (20:19). Width of head across eyes, 2.95 mm; interocular space moderately convex, smooth. Antennae as in Fig. 3.



FIGS. 3–5.—*Ranatra fabricii* Guérin-Méneville 3, Antenna; 4, left male paramere; 5, part of foreleg.

Prothorax long, slender, greatest length (measured on pleuron), 10.20 mm. Pronotum with posterior part a little dilated; widest near base, 3.10 mm; width of anterior part at apex, 2.25 mm; median length, 8.80 mm; anterior part scarcely more than twice as long as posterior part (61:29). Scutellum a little convex on anterior part, depressions well marked and separated by a median carina; posterior part with some transverse striae little marked.

Metaxyphus moderately elevated, with inferior surface smooth, feebly convex, broad in front, then slowly narrowed posteriorly and curving upward between the hind coxae. Metaxyphus a little less curved in female. Male parameres as in Fig. 4. Male operculum embraced at apex as in *R. annulipes*. Female operculum pointed at apex, slightly extending beyond extremity of abdomen, the lower edge curving gently upward as it narrows posteriorly.

Anterior legs with coxae 7.00 mm long; femora (fig. 5) 10.80 mm long, moderately large, the inferior edge not very much narrowed in the vicinity of the tooth as may be observed in the illustration. Apex of hind femora not quite attaining the extremity of the hemelytral membrane.

Size.—Length of body of male described, 33.80 mm; respiratory tubes, 34.30 mm; female, 33.00–35.00 mm. long; respiratory filaments, 34.00–36.00 mm.

Distribution.—Known only from Cuba, and widely disseminated on the island. Specimens have been examined from Havana, Nov. 1947, J. Ferrar (figured); Santiago de la Vegas, Havana, Jan. 6, 1940; Santa Clara, May 1911 (Amer. Mus. Nat. Hist.); "Cuba," Uhler Collection, U. S. Nat. Mus.; Matanzas, Feb. 6, 1946, Santiago de las Vegas, May 22, 1933, collected by Mr. Marino.

Affinities.—Distinguished from *R. annulipes* by the form of antennae and male parameres. The metaxyphus is more narrowed posteriorly and the curvature more pronounced in *R. annulipes*. As *R. fabricii* has been wrongly suppressed as identical with *R. annulipes*, it is here treated as a valid species. The differences between the two species may be noted by the dimensions given in the descriptions and structures figured. *R. sagrai*, n. sp., from Cuba is a larger, stouter species with longer prothorax and fore legs.

Ranatra sagrai, n. sp. (Figs. 6–7)

Female.—Long, robust, the caudal appendages a little longer than the body. Width across eyes, 3.25 mm. Eyes of median size; width of an eye and of interocular space subequal (20.5:21). Interocular space moderately convex, smooth. Antennae as in Fig. 6.

Prothorax long, moderately robust, (measured on pleuron) 11.85 mm long. Pronotum (measured on median line), 10.40 mm long; width at apex, 3.70 mm; width at widest part of base, 3.70 mm; front part practically twice as long as hind part (measured on median line) (69:36). Scutellum about the same as in *R. fabricii*. Female genital operculum scarcely surpassing extremity of abdomen, with inferior edge narrowed and moderately curved upward apically. Metaxyphus moderately elevated, with inferior surface smooth, slightly convex, broad in front and then slowly narrowed posteriorly, curving very little in the middle posteriorly.

Anterior coxae 8.00 mm long, without markings; femur (Fig. 7) 12.00 mm in length, robust, the inferior edge in the region of the tooth very little narrowed; tooth placed as in *R. fabricii*. Apex of hind femora not reaching to the extremity of the membrane.

Size.—Length of female, 38.00 mm; respiratory appendages, 42.00 mm.

Type (male).—Santiago de las Vegas, Cuba, collected by S. C. Bruner, in collection of C. J. Drake. Named in honor of Ramon de la Sagra, the author of *Historia Física, Politica Natural de la Isle de Cuba.*

Affinities.—Differs especially from *R. annulipes* by the form of the metaxyphus; from *R. fabricii* by its larger body, longer caudal filaments, longer anterior coxae and form of metaxyphus.

Ranatra zeteki, n. sp. (Figs. 8–11)

1905. *Ranatra annulipes* Montandon, Bull. Soc. Sci. Bucharest **18** (2–4): 394 (*part*; specimen from Panama).
1907. *Ranatra annulipes* Montandon, Ann. Soc. Ent. France **76:** 58 (*part;* specimens from Panama and Colombia).

Moderately long, moderately slender, respiratory appendages a little longer than the body. General color yellowish brown with legs banded or mottled with testaceous. Female usually longer than the male, also with longer respiratory filaments.

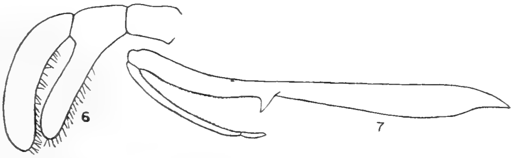
Size.—Length of body (male), 29.00–32.00 mm, the respiratory tubes, 31.00–34.50 mm; (female) length, 30.00–34.60 mm, the respiratory tubes, 35.00–40.00 mm.

Eyes large, the width of an eye and width of interocular space nearly equal (19:18, male; and 21:22, female). Interocular space moderately convex, smooth; jugae prominent, a little more elevated than tylus, testaceous. Width of head across eyes, 2.80 mm in male and 3.25 mm in female. Antennae as in Fig. 8.

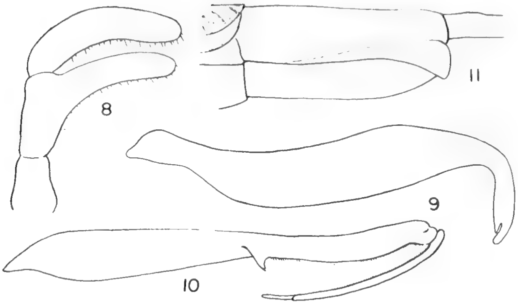
Pronotum long, rather slender, the front part more than twice as long as hind part (52:27); length on median line, 8.10 mm in male and 9.00 mm in female; width of hind lobe near base, 2.25 mm in male and 3.25 mm in female; width at anterior end of front lobe, 2.05 mm in male and 2.35 mm in female; hind lobe not greatly widened in either sex, deeply roundly excavated behind. Prothorax (measured on pleuron) 9.00 mm long in male and 10.16 mm in female. Scutellum with anterior part feebly convex, smooth, indistinctly rugulose, strongly impressed on each side just in front of middle, there with a thick median carina separating the two impressions; hind part triangular, strongly narrowed posteriorly, without transverse striae.

Metaxyphus high, wide in front, becoming strongly narrowed posteriorly, turning abruptly upward a little before hind margins of metacoxae. Male operculum (Fig. 11) embraced at apex as in *R. annulipes*. Male parameres as in Fig. 9. Apex of female operculum feebly surpassing last abdominal segment.

Legs long and slender, coxae and femora with pale testaceous spots or marks. Fore femora (Fig. 10) not very much narrowed on inferior edge in vicinity of the premedian tooth; length of male, 9.50 mm and female, 13.30 mm; length



Figs. 6, 7.—*Ranatra sagrai*, n. sp.: 6, Antenna; 7, part of foreleg.



FIGS. 8–11.—*Ranatra zeteki*, n. sp.: 8, Antenna; 9, left male paramere; 10, part of foreleg; 11, apex of male abdomen.

of fore coxae, 6.00 mm in male and 7.60 mm in female. Hind femora barely reaching base of genital segment; length, 13.40 mm in male and 18.60 mm in female. Length of female operculum, 3.10 mm. Length of abdomen, 16.80 mm in male and 18.75 mm in female. Middle and hind legs with broad testaceous bands.

Type (male) and *allotype* (female).—Panama, Canal Zone, Feb. 10–12, 1939, in Drake Collection. Paratypes, 32 specimens, taken with type in sluggish, salty waters, near the mouth of small streams emptying in to the sea or Panama Canal, and also in deep stagnant water of a narrow drainage ditch (all by C. J. Drake). One paratype, Panama, Canal Zone, April 14, 1911, E. A. Schwartz, U. S. Nat. Mus. Several other specimens have also been examined from Colombia and Venezuela. Paratypes in collections of both authors.

Affinities.—Separated from *R. annulipes* by the shape of the metaxyphus and male parameres. The eyes are also feebly wider than the width of interocular space.

Ranatra acapulcana, n. sp. (Figs. 12–14)

Male and female.—Long, slender, female a little stouter and longer than the male; respiratory filaments a little longer than the body in both sexes. Width of head across eyes, 2.80 mm (male) and 3.00 mm (female); width of an eye slightly greater than width of interocular space (19:18 in male and 20.5:19 female). Interocular space smooth, a little convex; jugae slightly more elevated than tylus. Antennae as in Fig. 12.

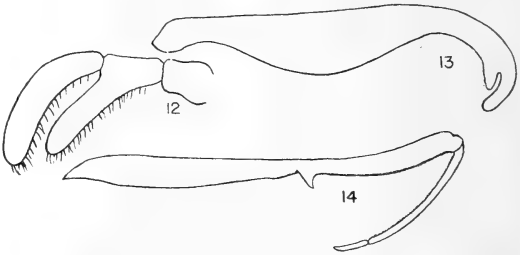
Prothorax long and slender, greatest length (measured on pleuron), 9.20 mm in male and 10.15 mm in female. Pronotum not much dilated behind; greatest width of hind part (near base), 2.80 mm in male and 3.25 mm in female; median length, 7.80 mm in male and 9.70 mm in female; anterior part slightly more than twice as long as hind part (55:23 in male and 67:30 in female); width at apex, 1.90 mm in male and 2.15 mm in female. Scutellum a little convex in the middle of anterior part, depression well marked and separated by a thick median carina, which is as long as the depressions; posterior part without transverse striae.

Male parameres as in Fig. 13. Male genital operculum enveloped at apex as in *R. annulipes*. Female genital operculum narrowed (slightly rounded) from near the base apically, the pointed apex scarcely surpassing extremity of the abdomen. Metaxyphus moderately elevated, a little convex at the middle, with inferior surface smooth, broad at the base, then narrowed posteriorly, ending behind in a pronounced curve between the hind coxae but not as vertical as in *R. annulipes.*

Anterior femora (Fig. 14) 10.00 mm long in male and 11.50 mm in female, a little narrowed on inferior edge in the vicinity of the tooth, the tooth placed as in *R. fabricii*; anterior coxae 6.60 mm long in male and 7.60 mm long in female, the exterior surface with pronounced pale and obscure fuscous markings. Hind femora marked with fuscous-brown spots, the apex reaching the extremity of the hemelytral membrane.

Size.—Length of male, 28.60–30.00 mm, and female, 36.00–39.00 mm; respiratory appendages, 29.00–32.00 mm in male and 36.00–39.00 mm in female.

Holotype (male) and *allotype* (female).—Taken in a large salt water lagoon, near Acapulco, Mexico, July 23, 1950 (C. J. Drake), in Drake Collection. Paratypes, taken with type, also in large fresh water ponds, near the salt water lagoon, Aug. 3, 1951, Drake and Hottes, in collections of both authors.



FIGS. 12–14.—*Ranatra acapulcana*, n. sp.: 12, Antenna; 13, left male paramere; 14, part of foreleg.

Affinities.—Differentiated from *R. annulipes* by the shape of male parameres, antennae and metaxyphus, also by the pale and obscure fuscous markings on femora and tibiae. *R. zeteki*, n. sp., has differently shaped male parameres. The metaxyphus also separates it from other members of the *annulipes* group.

Ranatra jamaicana, n. sp. (Figs. 15–17)

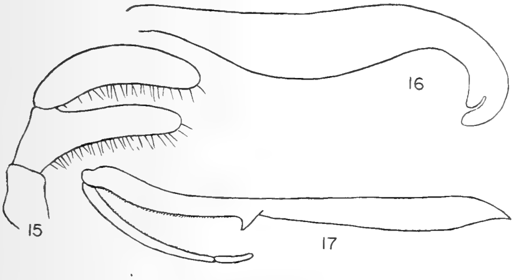
1899. *Ranatra annulipes* Kirkaldy, Entomologist **32**: 29.
1903. *Ranatra annulipes* Montandon, Bull. Soc. Sci. Bucharest **14** (3–4): 393–394 (*part*).

Male.—Body long, a little robust, the caudal appendages a little longer than the body. Width of head across eyes, 2.85 mm. Eyes of median size, width of an eye less than width of interocular space (18.5:20). Interocular space moderately convex, smooth; jugae distinctly more raised than tylus. Antennae as in Fig. 15.

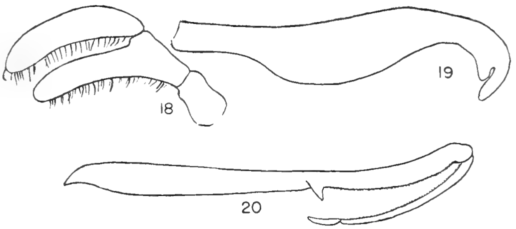
Prothorax moderately long; greatest length (measured on pleuron), 9.20 mm. Pronotum slender, anterior part slightly more than twice as long as posterior part (58:27); width at anterior end, 2.20 mm; width at widest place in hind part (near base), 3.00 mm. Scutellum as in *R. fabricii*. Metasternum with the longitudinal pale stripes a little obscure, the lateral ones extending on metacoxae and median on metaxyphus.

Male parameres as in Fig. 16. Male genital operculum enveloped at the extremity as in *R. annulipes.* Metaxyphus broad in front, rather slowly narrowed posteriorly to curvature, then strongly narrowed as it turns up between metacoxae.

Anterior femora (Fig. 17) 10.30 mm long, moderately thick, broad, with inferior edge in vicinity of tooth very little narrowed, the tooth situated as in *R. fabricii*. Marks on coxae and pale bands on middle and hind femora as in *R. fabricii*.



FIGS. 15–17.—*Ranatra jamaicana*, n. sp.: 15, Antenna; 16, left male paramere; 17, part of foreleg.



FIGS. 18–20.—*Ranatra absona*, n. sp.: 18, Antenna; 19, left male paramere; 20, part of foreleg.

Size.—Length of body, 31.00 mm; respiratory tubes, 31.00 mm.

Holotype male.—St. Andrews, Constant Springs, Jamaica, C. P. Taylor, in collection of C. J. Drake.

Affinities.—Differs from *R. annulipes* in the form of male parameres, smaller eyes, antennae and characteristics of the metaxyphus. These same structures also separate it from *R. absona*, n. sp. The type bears a label in Montandon's handwriting, which states that the specimen conforms with the type except that the obscure bands on the sternum are less indicated.

Ranatra absona, n. sp. (Figs. 18–20)

Male.—Body a little robust, the caudal appendages a little longer than the body. Width across eyes, 3.00 mm. Eyes large, the width of an eye slightly greater than width of interocular space (20.5:19). Interocular space moderately convex, smooth. Antennae as in figure 18.

Prothorax long and slender; greatest length (measured on side), 9.70 mm. Pronotum a little dilated behind; width of anterior part at apex, 2.10 mm; width at widest point of posterior part (near base), 2.80 mm; length on median line, 8.40 mm; front part a little more than twice as long as hind part (60:24). Scutellum practically the same as in *R. fabricii*. Mesosternum with the longitudinal stripes a little obscure, not extending posteriorly on metaxyphus.

Male parameres as in Figure 19. Apex of male operculum embraced as in *R. annulipes.* Metaxyphus moderately elevated, with inferior surface smooth, slightly convex, broad in front, then narrowed posteriorly, very little convex at the middle, terminating in an almost vertical curve between the metacoxae.

Anterior femora as in Fig. 20, rather thick medianly, with inferior edge bearing the tooth very little narrowed at the middle; 10.50 mm long; tooth situated as in *R. fabricii*; length of fore coxae, 6.60 mm. Apex of hind femora not attaining tip of hemelytral membrane. Intermediate and posterior femora with pale bands not very well marked.

Size.—Length of body of male, 32.00 mm; respiratory appendages, 33.50 mm.

Holotype (male).—Pinto Gordo, British Honduras, Feb. 1932, in collection of C. J. Drake, paratypes, 2 specimens, taken with type, one in collection of each author.

Affinities.—Differs especially from *R. annulipes* in the form of the male parameres, anterior femora and antennae; these structures also separate it from *R. fabricii.* The metaxyphus is more elevated, more curved and narrowed on posterior part than in *fabricii.* Also, the metaxyphus is broader on the anterior three-fourths of inferior surface than in *R. annulipes.*

Ranatra similis, n. sp. (Figs. 21–23)

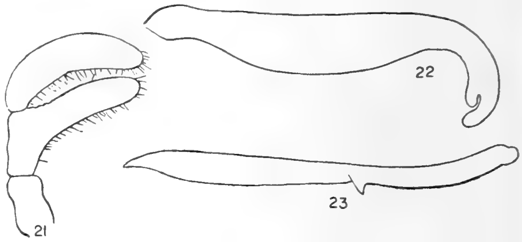
Male.—Long, body little robust, the caudal appendages a little longer than the body. Width of head across eyes, 3.00 mm. Eyes of median size; width of an eye slightly shorter than the shortest distance between them (21.5:19). Interocular space moderately convex, with fine transverse striae. Antennae as in Fig. 21.

Prothorax moderately long, slender, greatest length (measured on pleuron), 9.80 mm. Pronotum widened a little behind, the front part scarcely more than twice as long as hind part (57:28); length on median line, 8.50 mm; greatest width of hind part, 3.40 mm; width at apex of front part, 2.35 mm. Scutellum very similar to *R. fabricii.*

Metaxyphus moderately elevated, with inferior face slightly convex, a little widened in front, moderately narrowed from middle posteriorly, forming a pronounced curve behind. Apex of male operculum enveloped as in *R. annulipes.* Male parameres as in Fig. 22. Anterior legs with femora (Fig. 23) moderately broad, 11.00 mm long, with lower edge very little narrowed in vicinity of the tooth, which is placed as in *R. fabricii.* Apex of hind femora not quite reaching extremity of hemelytral membrane.

Type (male).—Satipo, Peru, July, 1940, collected by Pedro Paprachki, in collection of C. J. Drake.

Affinities.—Distinguished from *R. annulipes* by the form of the parameres, antennae and metaxyphus; from *R. jamaicana,* n. sp., by the same characters and besides there are no clear or obscure bands on the mesosternum. The metaxyphus in *R. similis* is narrowed posteriorly in its greatest part and then turns up more progressively between metacoxae. In *R. absona,* n. sp., and *R. annulipes* the metaxyphus turns up almost vertically between hind coxae.



Figs. 21–23.—*Ranatra similis,* n. sp.: 21, Antenna; 22, left male paramere; 23, part of foreleg.

Ranatra camposi Montandon

1907. *Ranatra camposi* Montandon, Ann. Soc. Ent. France **76:** 59.
1946. *Ranatra camposi* De Carlo, An. Mus. Arg. Cien. Nat. **42:** 16–17, 4 figs.

Female larger than male; respiratory filaments generally a little longer than the body, sometimes slightly shorter. Eyes large; width of an eye slightly greater than width of interocular space (20:19) interocular space moderately convex, smooth; jugae prominent. Antennae as in figure 24.

Prothorax moderately long, greatest length (measured on pleuron) 7.80 mm in male and 8.80 in female. Pronotum a little dilated behind, length (measured on median line) 6.90 mm in male and 7.80 mm in female; width at apex of anterior part 2.00 mm in male and 2.25 mm in female; width at widest point of hind part 2.70 mm in male and 3.10 mm in female.

Scutellum very little convex, with some transverse rugulae in front, with a thick carina separating the impressed areas just in front of tapering hind part; triangular hind part with transverse striae well marked.

Metaxyphus large, characters about the same as in *R. acapulcana.* Apex of female operculum slightly extending beyond extremity of last abdominal segment.

Anterior femora robust, with the upper edge near the tooth very little narrowed, 8.00 mm long in male and 10.20 mm in female, the tooth placed as in *R. fabricii.* Tip of hind femora barely reaching apex of hemelytral membrane.

Size.—Length, 25.80–27.40 mm (male) and 28.00–31.00 mm (female); respiratory appendages, 25.50–29.00 mm (male) and 26.85–3.20 mm (female). In most of our specimens the caudal filaments are slightly longer than the body. Montandon (1907) gives their length in the type as slightly shorter than the body.

Distribution.—The writers have examined more than 60 nymphs and adults from Guayaquil, Ecuador, all collected by Dr. Francisco Campos R. The types were also taken at Guayaquil by Dr. Campos.

Affinities.—The size of body, metaxyphus and male parameres separate *R. camposi* from *R. annulipes.* The smaller form, shorter caudal appendages and shorter fore legs separate it from *R. ecuadoriensis* De Carlo.

Ranatra ecuadoriensis De Carlo

1946. *Ranatra annulipes* De Carlo, An. Mus. Arg. Cien. Nat. **42**: 14–16, 3 figs. (*part*).

1950. *Ranatra ecuadoriensis* De Carlo, Rev. Bras. Biol. **10** (4): 525–526, figs. 9–10.

For a detailed description and illustrations of this species, see De Carlo's paper of 1950. The male is unknown. The following notes are based upon three females, Guayaquil, Ecuador, Jan. 26, 1952, taken in a temporary rainwater pool, Dr. F. Campos, in company with numerous specimens of *R. camposi* Kirkaldy.

General aspect very similar to *R. camposi*, larger and with the anterior femora and prothorax longer. Length of body, 32.50 mm; respiratory tubes, 34.50 mm; anterior femora, 10.30 mm; coxae, 7.10 mm; pronotum on median line, 8.80 mm. Antennae and anterior femora as figured by De Carlo (1950).

Affinities.—This species is most closely related to *R. camposi*, but is readily separated from it by the dimensions of the body, anterior legs, and respiratory appendages.

ENTOMOLOGY.—*An interesting new pyrgomorphine grasshopper (Orthoptera: Acrididae) in the U. S. National Museum.*

D. Keith McE. Kevan, University of Nottingham. (Communicated by Ashley B. Gurney.)

In the course of an examination of acridid material of the sub-family Pyrgomorphinae kindly lent to me for study by the Smithsonian Institution, I came across an interesting new species of *Chlorizeina* Brunner von Wattenwyl, 1893. Unfortunately it is known only from a few specimens but, since they considerably extend the known range of the genus, I do not think it inadvisable to describe it.

Chlorizeina malabarensis, n. sp.

Type: ♂, India, Mangalore, June [1925], J. C. Bridwell. U. S. National Museum No. 61121.

Head.—Antennae longer than head and pronotum together, filiform, the basal half slightly flattened. Eyes prominent, oval, a little longer than wide. Frons slightly rugose, strongly oblique, concave in profile. Frontal ridge strong, narrow, deeply sulcate throughout, not reaching the clypeus. Lateral carinae strong, almost straight and only slightly divergent. Cheeks with minute scattered punctures and with a partial oblique row of small, weak, rounded tubercles extending from behind the eye to the anterolateral angle of the pronotum. Fastigium verticis rugoso-punctate, longer than wide, rounded apically (Fig. 1, A). Median carinula of head faint but distinct throughout. Dorsal surface of head finely punctured all over, with fine transverse rugae in the vicinity of the median carinula, especially in front of the eyes.

Thorax.—Pronotum subcylindrical, strongly but finely punctured throughout, less so in the posterior part of the metazona; anterior margin slightly concave; posterior margin almost straight; median carina obsolescent; lateral carinae absent; transverse sulci fine, more or less straight, the median one placed at about the middle of the disc, the typical one at rather less than three-quarters (Fig. 1, A), anterior sulcus obsolescent, almost invisible; lateral pronotal lobes with anterior angle rounded, posterior angle forming a right-angle and inferior margin slightly sinuous. Mesonotum for the greater part concealed. Metanotum about equal to the metazona of the pronotum. Prosternal tubercle situated rather far forward, pyramidal, very slightly inclined backwards, very strongly acute. Mesosternal lobes about one and a half times as long as wide, their interspace of about the same dimensions as a lobe. Metasternal pits fairly large, deep, and separated by a distance equal to about one-third of the greatest width of a metasternal lobe.

Wings.—Tegmina abbreviate, almost reaching the posterior margin of the first abdominal tergum, ovate-lanceolate, about twice as long as wide, acutely pointed (Fig. 1, A), veins indistinct, costal margin slightly convex, anal margin strongly so and distinctly punctured. Hind wings minute, scale-like.

Genitalia.—Tenth abdominal tergum excised and carinate as illustrated (Fig. 1, B). Epiproct flat, tonguelike (Fig. 1, B). Cerci long, strongly inwardly and upwardly curved, extending to about the end of the epiproct, narrowed before the middle and slightly thickened apically (Fig. 1, B, C). Subgenital plate obtuse.

Measurements.—Length 38; antenna 16.5; head 7.0; pronotum 7.5; tegmen 6.5; hind femur 20.5 mm.

Coloration.—More or less uniform olive-green [somewhat discoloured] except for the dark brown antennae, brown eyes, dark green gular area above the diagonal row of yellowish cheek tubercles, and the pink inferoexternal area of the hind femur.

ALLOTYPE: ♀, India, Goa, Mormugao, Sept. 1925, J. C. Bridwell.

Agrees with the type but is larger with a less cylindrical pronotum which is considerably wider behind than in front; the mesosternal lobes are scarcely longer than wide and their interspace is greater than the width of a lobe; metasternal pits separated by a distance equal to more than half a metasternal lobe. The tenth abdominal tergum is excised to the posterior margin of the ninth, the epiproct is broader than in the male and the cerci are short, straight and stout, about half as long as the epiproct. The ovipositor valves are short and stout.

Measurements.—Length 45; antenna 16.0; head 7.0; pronotum 9.5; tegmen 7.0; hind femur 20.5 mm.

PARATYPE: ♂, Same data as the allotype (British Museum).

Agrees with the type but is a little smaller and paler.

This new species is much larger than any of the three previously described. In build it resembles more closely *C. unicolor* Brunner von Wattenwyl, 1893 (*cf.* Ramme, 1941, pl. 12, figs. 1a, 1b, 2), but the genitalia are more like those of *C. ele-*

FIG. 1.—*Chlorizeina malabarensis*, n.sp.: A, Head and thorax of male (type), dorsal; B, male genitalia, dorsal; C, male cercus, lateral.

gans Ramme, 1941 (*cf.* Ramme, *l.c.*: 36, Abb. 13), although the cerci are distinctly more strongly curved.

A third species, *C. togulata* Rehn (1951), described from the Southern Shan States, Burma, has much broader cerci than those of *malabarensis*.

The genus was previously known only from Burma, and it is interesting to find that its range extends to the west coast of India. *C. elegans* is known from Upper Burma; *C. unicolor* was previously known only from Lower Burma but is now known to me from Upper Burma also.

REFERENCES

Ramme, W. *Beiträge zur Kenntnis der Acrididen-Fauna des indomalayischen und benachbarter Gebiete (Orth.) mit besonderer Berücksichtigung der Tiergeographie von Celebes.* Mitt. zool. Mus. Berl. **25**: 1–243, 21 pls. 1941.

Rehn, J. A. G. *A new species of the genus* Chlorizeina *(Acrididae; Pyrgomorphinae)* from Burma. Notulae Nat., no. 238: 1–7, 6 figs. 1951.

ENTOMOLOGY.—*On a collection of* Phlebotomus *from the Yemen.*

Oskar Theodor, Department of Parasitology, Hebrew University, Jerusalem. (Communicated by C. W. Sabrosky.)

The collection dealt with in the present note was made by Lt. Comdr. K. L. Knight, of the U. S. Naval Research Medical Unit No. 3, Cairo, Egypt, in January 1951 in southern Yemen. Practically nothing is known of the sandfly fauna of Arabia and these records may be considered as new. The collections made by Commander Knight are as follows:

Coll. 304. Ta'izz, Yemen. Jan. 12, 1951. Elev. 4,100 feet. Trapped on oiled paper at base of stone walls at damp spots by cess-pit drainages, in the city proper. *P. sergenti, P. langeroni* var. *orientalis, P. chinensis arabicus,* n. subsp., *S. tiberiadis.*

Coll. 306. Ta'izz, Yemen, Jan. 14, 1951. Elev. 3,590 feet. Trapped on oiled paper at entrances of rodent burrows (mostly *Arvicanthus* sp.) on an aloe-euphorbia hillside. Outside the town about 3 miles. *P. papatasii* var. *bergeroti, P. roubaudi, P. langeroni* var. *orientalis, S. africana, S. schwetzi, S. antennata* var. *cincta.*

Coll. 307. Ta'izz, Jan. 15, 1951. Same as coll. 304. Same species.

Coll. 309. El-Hauban, Wadi el-Maleh, about 3 miles east of Ta'izz. Jan. 17, 1951. Elev. about 3,700 feet. Trapped on oiled paper in rodent burrows at base of small rock cliff. *P. roubaudi, S. tiberiadis.*

Coll. 15. Ta'iz, Yemen. Jan. 21, 1951. Caught biting a number of small boys sitting near our quarters in town. From dark until 19:45 hours. Bright moon. *P. papatasii* var. *bergeroti, P. sergenti, P. langeroni* var. *orientalis, P. chinensis arabicus* n. subsp.

Genus **Phlebotomus** Rondani, 1840

Subgenus **Phlebotomus** Rondani

Phlebotomus papatasii var. **bergeroti** Parrot, 1934

3 ♂♂, 1 ♀ coll. 306; 1 ♀ coll. 15, biting man in Ta'izz. The species has been recorded from Djanet in southern Algeria, from Abyssinia, and the Anglo-Egyptian Sudan.

Phlebotomus roubaudi Newstead, 1913

1 ♀, 5 ♂ ♂ coll. 306; and 1 ♀ coll. 309 from rodent burrows.

This species was originally described from Akjoucht in Mauretania and has subsequently been found to occur in a belt south of the Sahara throughout Africa. It has been found by Kirk and Lewis west of Lake Rudolf in the Anglo-Egyptian Sudan.

The absence of typical *P. papatasii*, which is closely related to these two species and which occurs commonly in the Anglo-Egyptian Sudan (together with *P. papatasii* var. *bergeroti* but not with *P. roubaudi*) is noteworthy.

Subgenus **Paraphlebotomus** Theodor, 1948

Phlebotomus sergenti Parrot, 1917

2 ♂♂, 2 ♀ ♀ coll. 304/307; 1 ♀. coll. 15, biting man in Ta'izz. This species is known from the central Sahara, French West Africa, the southern Mediterranean, and from the Middle East, extending into North West India. It is very common in Bagdad, where it is the main carrier of Oriental sore and rare in Palestine. It has not been recorded from the Anglo-Egyptian Sudan or from Abyssinia, where 2 other species of the subgenus occur (*P. alexandri* and *P.*

sergenti var. *saevus*). It may therefore be assumed that *P. sergenti* reached Arabia from the north.

Subgenus **Laroussius** Nitzulescu, 1931

Phlebotomus langeroni var. **orientalis** Parrot, 1936

38 ♀♀ coll. 15, biting man in Ta'izz; 5 ♂♂ coll. 304/307; 12 ♂♂ coll. 306 from rodent burrows.

This is the most numerous species in the collection. It was raised to specific rank by Parrot in 1946, but the differences from *P. langeroni* are so small that it is probably better regarded a variety or subspecies of *P. langeroni*. *P. langeroni* var. *orientalis* is known from Abyssinia and from the Anglo-Egyptian Sudan, mainly in the area west of Lake Tana. It is the only common representative in the area of the subgenus *Laroussius* (major group), which contains the principal carriers of Kala Azar in the Mediterranean, and it is considered the carrier of Kala Azar in the Sudan. *P. longipes*, which also belongs to this subgenus, has, according to Kirk and Lewis, been found only in one locality in the Sudan, from which Kala Azar is not known.

A few cases of Kala Azar have been recorded from Arabia. Two cases were recorded by Phillips (1904) in adults of 30 and 35 years of age from the Yemen and the Hedjaz. Whittingham (1937) mentions the case of a British officer who contracted the disease in Aden. Two further cases were recently recorded by Fawdry and Mazhar (1951) in children of 4 and 6 years, one from Ta'izz and the other from Beidha, 150 miles north of Aden. Two cases were recently diagnosed in Jerusalem in immigrants (young adult males) from the Yemen (unpublished). According to the age distribution of the few cases known from Arabia, the disease seems to be of the Sudanese type of Kala Azar, which according to Kirk "is chiefly a disease of late childhood and early adult life" and not as Mediterranean Kala Azar mainly a disease of young infants. Whittingham mentions that the sandflies from Aden were repeatedly identified as *P. perniciosus*. This species, which occurs only in the western Mediterranean, was not then distinguished from *P. langeroni* and its related forms. Presumably the sandflies from Aden were also *P. langeroni* var. *orientalis*. This species is thus apparently common in southern Arabia and bites man as the present records show. *P. langeroni* var. *orientalis* may therefore be considered also as the carrier of Kala Azar in southern Arabia.

Subgenus **Adlerius** Nitzulescu, 1931

Phlebotomus chinensis arabicuş, n. subsp

1 ♂, 1 ♀ coll. 304/307; 1 ♀. coll. 15, Ta'izz, biting man.

The occurrence of a form of *P. chinensis* in southern Arabia is very interesting. The species consists of 6 or 7 local forms, which are widely distributed throughout Asia, including northern India and China, the Middle East, and the eastern Mediterranean. None has been recorded so far from the Ethiopian region or North Africa. The various forms differ in the male mainly in the shape of the penis and the length of the genital filaments and in the armature of the pharynx in the female and in various measurements. The status of these forms has not yet been finally determined and a study of the whole group is required. They will probably have to be made into subspecies or even species.

Female.—Size 2.5 to 3 mm. Wing, length 2.5 to 2.9 mm; width 0.6 to 0.8 mm. Wing index α/β = 1.8 to 2.3 mm. Palp formula: 1, 4, (2, 3), 5. Relative length of segments: 1-4-4-3.4-8. Antennae: Segment 3 > 4 + 5. A3/E = 1. Armature of pharynx rather similar to that of *P. chinensis* var. *simici*, extending forward about a quarter of the length of the pharynx. Spermatheca as in the other forms of *P. chinensis*.

Male.—Size 2.5 mm. Wing, length 2.5 mm; width 0.65 mm. Wing index α/β = 1.7. Palp formula 1, 4, 2, 3, 5, . Relative length of segments: 1-3.3-3.8-3-9. Antennae: Segment 3 > 4 + 5. A3/E = 1.5.

Genital filaments eight times as long as pump. Penis with a very shallow subterminal tubercle, which is rather far removed from the tip.

The subspecies from the Yemen resembles most closely the form from Cyprus but differs in the antennal index A3/E, which is 0.7 in the ♀ and 1.1 in the ♂ in the Cyprus form. The genital filaments are longer (6.6 times as long as the pump in the Cyprus form) and the subterminal tubercle is shallower and further removed from the tip than in the Cyprus form.

Type at present in the author's collection.

Genus **Sergentomyia** Franca, 1920

Subgenus **Sergentomyia** Franca

Group fallax

Sergentomyia antennata var. **cincta** Parrot and Martin, 1944

3 ♀♀, 4 ♂♂ coll. 306, from rodent burrows.

The species occurs in the Anglo-Egyptian Sudan, French Somaliland, and Uganda. It has 14 to 20 teeth in the buccal cavity and a rather narrow pharynx with relatively coarse teeth in the female. The specimens from the Yemen agree well with the description of the species. There are about 20 teeth in the buccal cavity of the female.

Sergentomyia schwetzi Adler, Theodor, and Parrot, 1929

2 ♀♀, 1 ♂ coll. 306, from rodent burrows.

Group africana

Sergentomyia africana Newstead, 1912

3 ♀♀ coll. 306, from rodent burrows.

Kirk and Lewis (1951) propose to change the name of the species to *S. freetownensis*. This change, however, requires a ruling of the International Commission for Zoological Nomenclature, suppressing the name *S. africana*. The old name is therefore retained until the nomenclatorial position is clarified.

Subgenus **Sintonius** Nitzulescu, 1931

Sergentomyia tiberiadis Adler and Theodor, 1930

Syn. **S. subtilis** Parrot and Martin, 1944

6 ♂♂, 1 ♀ Ta'izz, coll. 304/307; 1 ♂ coll. 309, El-Hauban.

The species was recorded from Abyssinia by Parrot in 1936 as *P. tiberiadis*. Later Parrot described the male of the species as *P. subtilis*, and in 1940 Parrot redescribed both sexes under the name *P. subtilis*. Comparison of the type specimens of *P. tiberiadis* from Palestine with specimens of Parrot's original series, with specimens from the Sudan, and with the specimens from the Yemen showed that there are practically no constant differences between the material from the different localities. The characters on the basis of which Parrot separated *S. subtilis* from *S. tiberiadis* are so small and variable that they do not justify the retention of *S. subtilis* as a separate species.

The *Phlebotomus* fauna of the Yemen is thus, as was to be expected, mainly Ethiopian in character. Seven out of the 9 species recorded occur in Abyssinia and the Anglo-Egyptian Sudan. Only one Mediterranean species, *P. sergenti*, and a new subspecies of *P. chinensis* were found, the various forms of which are widely distributed in Asia and the eastern Mediterranean.

REFERENCES

Fawdry, A. L., and Mazhar, M. *Two cases of Kala Azar in South Arabia.* Trans. Roy. Soc. Trop. Med. and Hyg. **45**: 138, 1951.

Kirk, R., and Lewis, D. J. *The Phlebotominae of the Ethiopian Region.* Trans. Roy. Ent. Soc. London **102**: 383, 1951.

Lewis, D. J., and Kirk, R. *The sandflies of the Anglo Egyptian Sudan.* Bull. Ent. Res. **41**: 459. 1951.

Phillips, L. *On the occurrence of the L.D. parasite in Arabia and Egypt.* B.M.J. **195**: 657. 1904.

Whittingham, H. E. Trans. Roy. Soc. Trop. Med. and Hyg. **30**: 403. 1937.

BIOLOGY.—*New records of* Diaptomus sanguineus *and allied species from Louisiana, with the description of a new species* (*Crustacea: Copepoda*).

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Marsh's record of the occurrence in Louisiana of the fresh-water copepod *Diaptomus sanguineus* Forbes appears to be based upon personal correspondence with Edward Foster (see Marsh, 1929, pp. 13, 15, and 17), whose manuscript records were published by Penn (1947). This lists the species as occurring near Slidell, in St. Tammany Parish, rather than near New Orleans as given by Marsh. Collections made in 1951 and 1952 by one of us (Moore) indicate that the species is very common in St. Tammany Parish, where it occurs in seasonal ponds and ditches, frequently in association with *Diaptomus stagnalis* and *D. conipedatus*. Collections made near Alton and Florenville from January to February 29 contained adults; most females collected on the latter date were ovigerous. The species also has been found in temporary pools and ponds north of Alexandria, Rapides Parish, in the central part of the State. Here most of the specimens found on December 28 were immature; only adults were present in collections made on April 6.

Two species allied to *sanguineus* have

been found in our Louisiana collections. The little-known *Diaptomus virginiensis* and a new species are described below from specimens collected in St. Landry and Evangeline Parishes.

Diaptomus (Onychodiaptomus) virginiensis Marsh

Figs. 11–12; 21–25

Diaptomus virginiensis Marsh, 1915, p. 457, figs. 1–5; 1929, p. 23.

Specimens examined.—Type lot: from Marsh collection in U. S. National Museum, Marsh nos. 4064, 4067, 4154. Great Falls, Va.

Louisiana: 20 ♀ (4 ovigerous), 1 ♂, ditch pond on U. S. Highway 71, south of Lebeau, St. Landry Parish, April 5, 1951, W. G. Moore; 6 ♀, same location (ditch ponds on opposite sides of highway—4 ♀ in one, 2 ♀ in other), December 27, 1951, W. G. Moore.

The only record of this species in literature is that of the type locality in Virginia. The Louisiana specimens agree very closely with the type material examined, so that there is no doubt of the identity of the species.

The Louisiana specimens are a little larger than those recorded by Marsh: ♀, 1.41–1.61 mm, ♂, 1.3 mm. (Marsh's figures are: ♀, 1.366, ♂, 1.24 mm).

The illustrations given here are all drawn from the Louisiana specimens. There are no differences between the fifth leg of the Louisiana male and the type specimens from Virginia. Such differences as appear when Fig. 22 is compared with Marsh's description and illustration (Marsh, 1915, fig. 5) have not been found to exist in the types. These include the greater length of the spine of the right basipod segment 1, the presence of the small sclerotized lamella of the distal outer portion of basipod 2, the presence of the prominent double-lined ridge of the second exopod segment, and the greater length of the lateral spine, which is placed at the middle of the segment and reaches to or beyond its apex.

The proximal pad of the apical segment of the left exopod does not occupy half of the inner margin as stated by Marsh; he must have included a portion of the distal pad which covers most of the posterior face. The inner process arises near the distal part of this pad (Fig. 23) and forms a pincer with the distal process, as in *sanguineus*. The distal process is stout and digitiform, its length a little less than one-half that of the outer margin of the segment (7:16).

Marsh has not described the urosome of the male, which is moderately asymmetrical. Groups of minute spinules such as those found on the dorsal face of the fourth segment in the Louisiana specimen (Fig. 21) are also present in the type material. These have not been found in any other species of the group.

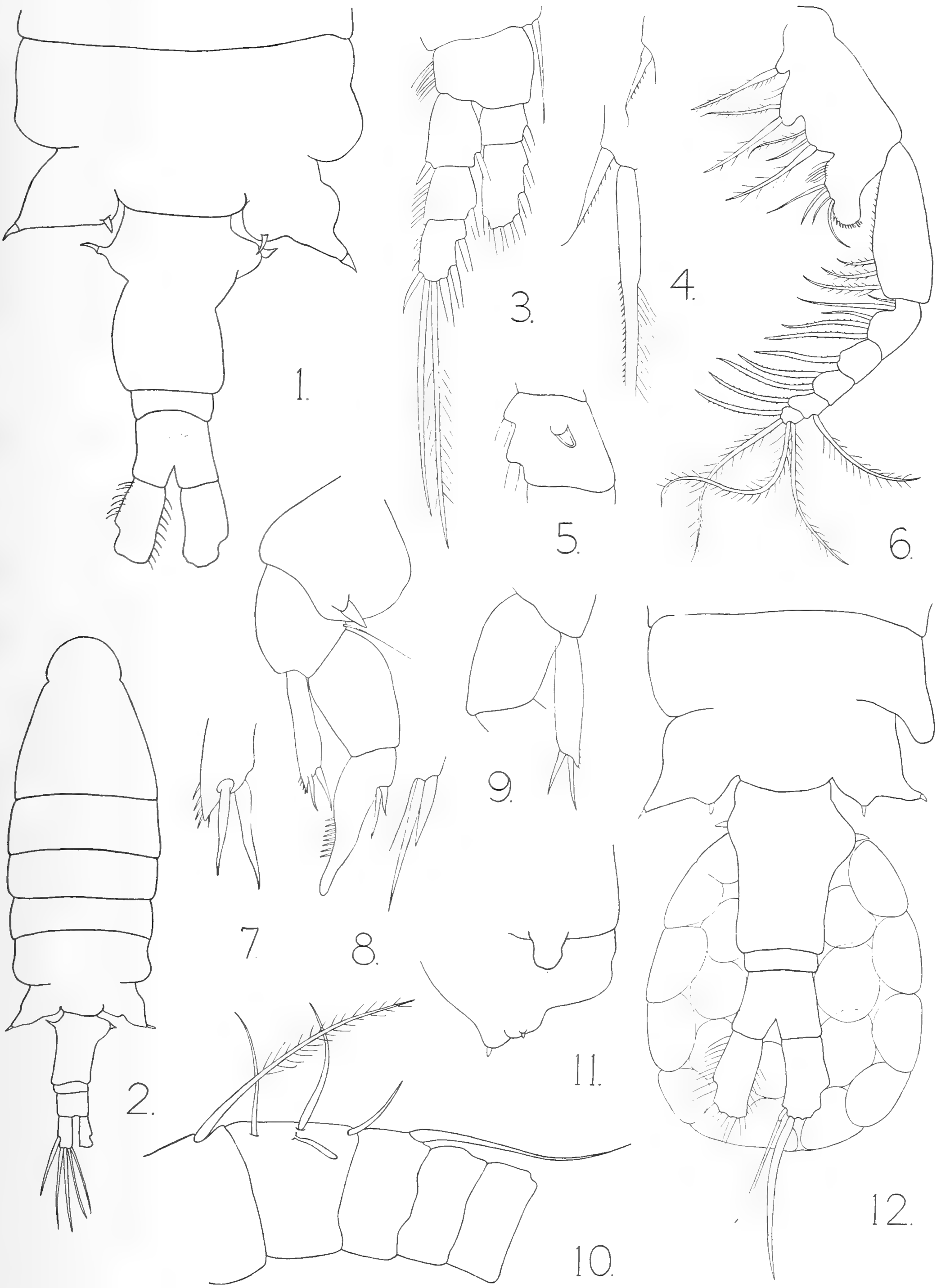
The important characters of the right antennule of the male have not been described. The Louisiana specimen agrees exactly with those of the type lot. The relative development of the spines of segments 10, 11, and 13 are unusual in North American diaptomids (Fig. 25). Those of 10 and 11 are very short, being only a little longer and stouter than the minute spines of segments 8 and 12. That of segment 13 is excessively large, reaching to about the middle of segment 15. The relative lengths of the spines are:

Segment	8	10	11	12	13
Spine	3	4	5	3	46

Segment 15 has a moderately sized spinous process, segment 16 a minute process; both are placed at the middle of the segment. The setation of the left antennule agrees with that of the female.

The females of the Louisiana collection of *virginiensis* have a noticeable backwardly directed lobelike protrusion on the right side of the fifth metasomal segment (Figs. 11 and 12). The wings of the last segment are a little asymmetrical; the left may have the inner lobe well developed as shown in Fig. 12 or the entire margin may be nearly straight. The genital segment of the Louisiana specimens agrees with the type in not having the pronounced asymmetry and great lateral expansion found in the allied species; the lobe of the right side is usually only a little larger than that of the left, and there are no other expansions or modifications.

The antennule is of the "little setaceous" type, with one seta on segments 11 and 13–19. The seta of segment 1 reaches to about the middle of segment 2, and is nonplumose. There is a cuticular lappet on the second segment of the endopod of leg 2. The general aspect of the fifth leg is much like that of the new species described below, from which it usually differs in having the setae of the endopod extremely short.



FIGS. 1–10.—*Diaptomus louisianensis*, n. sp., female: 1, Metasome segments 5–6 and urosome, dorsal; 2, dorsal outline of body; 3, leg 1; 4, leg 1, detail spines of exopod segments 1 and 3; 5, leg 2, endopod segment 2; 6, maxilliped; 7, leg 5, detail endopod setae; 8, leg 5, with detail of setae of exopod 3; 9, leg 5, showing variation in length of endopod; 10, antennule, detail of setae of segments 1–3;

FIGS. 11–12.—*Diaptomus virginiensis* Marsh, female (St. Landry Parish, La.): 11, Metasome segments 5–6, right side, lateral; 12, metasome segments 5–6 and urosome of ovigerous specimen, dorsal.

Diaptomus (Onychodiaptomus) louisianensis, n. sp.

Figs. 1–10; 13–20

Specimens examined.—Type lot: 6 ♀, 1 ♂, ditch in Chicot State Park, Evangeline Parish, La., December 27, 1950, W. G. Moore. Holotype ♀ (whole, alcoholic), U. S. N. M. no. 93271.

7 ♂, ditch pond, south of Lebeau, St. Landry Parish, La., April 5, 1951, W. G. Moore.

Female.—Length, about 1.85 mm (metasome, 1.40 mm, urosome, 0.45 mm). Dorsal view: head rounded (Fig. 2), cephalic segment behind antennal area greatly widened, its distal portion and segments 2–4 nearly parallel; the greatest width in segment 2, equaling about 30 per cent of the total body length. Segments 5 and 6 not separated dorsally, the right side of segment 5 differing slightly from the left, having the distal half more rounded. The wings of the last segment well developed (Fig. 1), noticeably asymmetrical, that of the left side without lobes, the posterior margin nearly straight; the right side having a conspicuous lobe on both the outer and inner proximal portion, the tip drawn out to a point.

The urosome 3-segmented (Fig. 1). The genital segment having each side of the proximal portion produced into conspicuous lateral lobes tipped with stout sensory spines, the lobe of the right side larger and more rounded than that of the left. Segment 2 short; segment 3 and the caudal rami subequal in length to one another; both margins of the rami armed with hairs. The inner dorsal seta nearly as long as the inner terminal caudal seta.

Antennules reaching to near the end of the urosome. The seta of segment 1 reaching to a little beyond the middle of segment 3, its tip plumose (Fig. 10); that of segment 3 subequal to that of 1. The numerical setation as in other species of *Onychodiaptomus*: 1 seta on segments 11 and 13–19. The setae of segments 16, 18 and 21 of considerable length and stoutness, all conspicuously plumose; that of 16 reaching to the middle of segment 20; that of 18 to the middle of 22. The short, modified setae of segments 17, 19, 20, 22 not particularly stiff, their tips straight and slender, each longer than or nearly as long as its segment.

The maxilliped (Fig. 6) not stoutly developed; each basal segment and the endopod subequal to one another; the inner setae of the endopod all weakly developed, shorter than the endopod and the terminal and outer setae of the last two segments, the longest of which are about as long as the endopod itself. The distal lobe of the basal segment conspicuously produced, with four setae. The relative lengths of the setae of the basal segment:

lobe 1	lobe 2	lobe 3	lobe 4
20	17:20	15:10:23	15:9:7:10

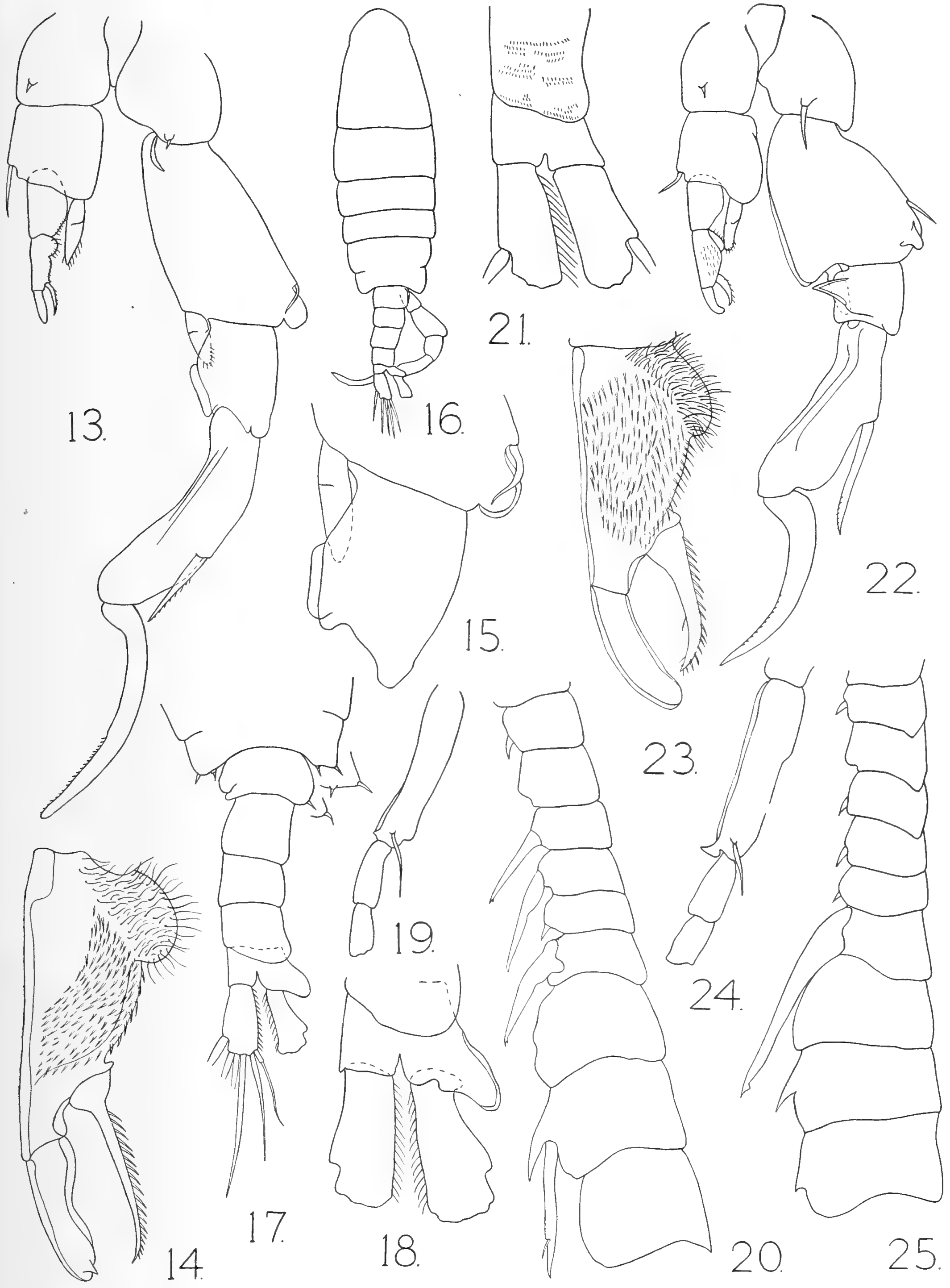
Leg 1 (Fig. 3) having fine, inconspicuous hairs on the outer margins of exopod segments 2 and 3. The outer spines of segments 1 and 3 spiniform (Fig. 4), both relatively weak and short, proportions to one another, 5:7; both with minute marginal serrations and tipped with sensory hairs. The outer terminal modified seta not at all spiniform, longer than the total exopod (50:40), a little weaker and shorter than the other setae of the segment, its outer margin minutely serrate, its inner plumose.

Leg 2 with a cuticular lappet on the second segment of the endopod (Fig. 5).

Leg 5 (Fig. 8) rather stout, the spine of the basal segment large and flat. The first exopod segment broad, greatest width to length of outer margin about 17:30. Exopod 2 longer than exopod 1 (35:30), with long, slender spinules on the inner margin. Outer seta of segment 2 not present. Exopod 3 not developed, its setae present, very closely set; the outer a stout spine, the inner a more slender seta about twice the length of the outer, and reaching to near the middle of exopod 2.

The endopod long, reaching a little beyond (Fig. 8), or considerably beyond the inner margin of exopod 1 (Fig. 9); its inner margin produced to a conspicuous protrusion armed with spinules which continue on to the face of the endopod. The apical setae sinuous (Fig. 7), their bases a little enlarged, one a little stouter than the other; their length usually less than half that of the endopod.

Male.—Length about 1.33 mm. The head rounded as in female, the rest of the metasome not so abruptly widened (Fig. 16). Segments 5 and 6 not separated dorsally, the posterior portions of segment 6 with 2 spines. The genital segment with a slender spine on the right side. The urosome conspicuously asymmetrical in the distal portion (Figs. 17 and 18). Segment 4 considerably produced dorsally on the right side; segment 5 having the right side produced laterally into a large, backwardly directed, marginally sclerotized lobe. The left caudal ramus straight,



Figs. 13–20.—*Diaptomus louisianensis*, n. sp., male: 13, Leg 5, posterior; 14, leg 5, detail left exopod segment 2, posterior; 15, leg 5, detail distal part of right basipod segment 2 and exopod 1; 16, dorsal outline of body; 17, metasome segments 5–6 and urosome, dorsal; 18, detail of urosome segments 4–5 and caudal rami, dorsal; 19, right antennule, apical segments; 20, right antennule, segments 8–16.

Figs. 21–25.—*Diaptomus virginiensis* Marsh, male (St. Landry Parish, La.): 21, Detail of urosome segments 4–5 and caudal rami, dorsal; 22, leg 5, posterior; 23, leg 5, detail left exopod segment 2, posterior; 24, right antennule, apical segments; 25, right antennule, segments 8–16.

the right narrowed proximally and widened distally; both rami with inner marginal hairs.

The left antennule with the same setation as in the female; the seta of segment 1 reaching only to the middle of segment 2. The right antennule (Fig. 20) with the spine of segment 8 not enlarged. The spines of segments 10, 11 and 13 all longer than the width of their segments, relative lengths of spines of two specimens: 18:23:24 and 16:21:25. The spine of 13 reaching to about the middle of 14. Segments 14–16 very swollen; segment 15 with a large spinous process arising at the middle and reaching to near the end of the segment; segment 16 lacking a process. The modified setae of 15–17 unusually stout, the tongue-like process very short and not arising close to the end of the seta. The twenty-third segment (Fig. 19) produced to a minute hook-like process, accompanied by a very narrow lamella.

Maxilliped, leg 1 and leg 2 like those of the female.

Leg 5 (Fig. 13) comparatively elongate and slender, the left ramus hardly reaching beyond the basipod of the right ramus. The sensory spines of both basal segments minute. The second basipod segment of the right leg elongate, its distal portion widened, but not conspicuously so, not swollen on the inner side, the outer portion produced into a rounded lobe (Fig. 15); a large, crescent shaped ridge on the inner proximal posterior face. Exopod 1 longer than wide; with a narrow rectangular hyaline lamella on the inner distal margin. The second exopod segment elongate and narrow (length to width 50:15); with an inner marginal ridge. The spine of the outer margin reaching to the apex of the segment, placed below the middle of the segment at about 68 per cent of its total length. The claw thick throughout, subequal in length to the exopod, 52:50. Endopod indistinctly 2-segmented, reaching to the middle of exopod 1.

The second basipod segment of the left ramus about as long as the first, broad throughout. The exopod set deeply into the basal segment, its width greatly reduced. The two segments subequal in length to one another (measuring to the base of the distal process). The apical segment (Fig. 14) having the proximal pad reduced in size, protruding medially but not extending distally to the middle of the segment. The distal pad confined to the posterior face, its medial and distal boundaries outlined below by heavy

TABLE 1.—COMPARISON OF CHARACTERS OF *Diaptomus sanguineus* GROUP

Character	*sanguineus*	*virginiensis*	*louisianensis*	*hesperus*
♀ *Metasome*				
Segment 5 with right lateral protrusion	—[1]	+[1]	—	—
Segment 6 with elongate spines	+	—	—	—
"Wings" strongly asymmetrical	—	—	+	—
♀ *Urosome*				
3-segmented	+	+	+	—
Genital segment strongly asymmetrical	+	—	+	—
♂ *Urosome*				
Segment 4 strongly asymmetrical	—	—	+	—
Segment 4 with dorsal spinules	—	+	—	—
Segment 5 strongly produced. right side	—	—	+	+
♂ *Right Antennule*				
Spines:				
8: enlarged	+	—	—	—
10–11: as long as or a little longer than segment width	+	—	+	+
13: reaching to end of 14 or beyond	—	+	—	—
Processes:				
15: present	+	+	+	+
16: present	—	+	—	+
♂ *Leg 5, right*				
Basipod 2 greatly broadened	+	+	—	—
Basipod 2 with outer elongate process	+	—	—	—
Lamella exopod 1 prominent	—	+	—	+
Lamella shape	narrow, rounded	triangular	narrow, rectangular	tongue-like
Exopod 2, lateral spine below middle of segment	+	—	+	+
♂ *Leg 5, left*				
Distal pad posterior only (not bulging medially)	+	+	+	—
Inner process arising below proximal pad	—	—	—	+
Inner process reaching to near end of distal (forming pincer)	+	+	+	—
♀ *Leg 5*				
Slender (length exopod 1 more than 3 times width)	—	—	—	+
Inner seta of exopod 3 reaching beyond middle of claw	+	—	—	—
Endopod setae more than half length of endopod	—	—	—	+

[1] + refers to the presence of a character, — to its absence.

sclerotizations, the short stout hairs recumbent and curving toward the outer margin. The distal process continuous with but clearly demarcated from the segment, its length about one half of the outer margin of the segment, digitiform, curving inwards, the cuticle at its tip notched so as to form a short spinous projection. The inner process arising below the distal pad, its base thickened but otherwise very slender, curving toward and reaching to near the end of the distal process so as to form a pincer; set thickly with spinules on the inner side only; the heavy sclerotized medial portion of the segment produced at its base into a characteristic point.

The endopod reaching to about the middle of exopod 2; indistinctly 2-segmented, its anterior face and medial margins set thickly with stout spinules.

COMPARISON OF SPECIES OF THE SANGUINEUS GROUP

The subgenus *Onychodiaptomus* Light (1939) may be divided by the structure of the male right fifth leg into two convenient taxonomic groups: the *birgei* and the *sanguineus*. In *Diaptomus birgei*, the only known species of its group, the second basipod segment and the exopod, including the claw, differ from the *sanguineus* group, except for the presence of a prominent hyaline lamella on the inner portion of exopod 1. In all other characters, both sexes of *birgei* show unmistakable relationship to the *sanguineus* group. Coker (1926) and Kiefer (1931) have given useful descriptions of *birgei*. The conspicuous ventral lobe found in the female distad to the genital protrusion, is not present in the other species of the subgenus.

The *sanguineus* group includes four species: *D. sanguineus* Forbes, 1876; *D. virginiensis* Marsh, 1915; *D. hesperus* M. S. Wilson and Light, 1951; and *D. louisianensis*, n. sp.

These species agree in the similarity of pattern of the right male fifth leg which is characterized by modification of the second basipod segment and shortness of the claw. The species differ from one another most noticeably in the structure and armature of the second basipod segment and the shape and size of the lamella of exopod 1. There are definable differences in the left exopod. *D. hesperus* is strikingly diverse in that the inner process is so placed that it does not form a pincer with the distal process as in the other species; in this, it is more like *D. birgei*.

Diaptomus sanguineus is a well-defined species; its important diagnostic characters have been reviewed by Humes and Wilson (1951). Louisiana specimens show no significant differences from the Massachusetts specimens studied in that report. The female is easily distinguished from all other North American diaptomids by the unique development of the last metasomal segment, which is not expanded into the usual "wings" but instead has both sensory spines greatly enlarged. Throughout its wide distributional range there is no variation in this character, except for slight differences in the length of the spines. The male is distinguished by the elongation of the usual short spine on segment 8 of the right antennule and by the spiniform elongation of the outer distal corner of the right second basipod segment of the fifth leg. Though variable in length, this process is specifically distinct and differs from the modification or armature found in the other species.

Table 1 gives a summary of the useful taxonomic characters separating the species.

LITERATURE CITED

Coker, Robert E. *Plankton collections in Lake James, North Carolina—copepods and Cladocera.* Journ. Elisha Mitchell Sci. Soc. **41**: 228–258, pls. 34–44. 1926.

Forbes, S. A. *List of Illinois Crustacea with descriptions of new species.* Bull. Illinois Mus. Nat. Hist. **1**: 3–25, 1 pl. 1876.

Humes, Arthur G., and Wilson, Mildred Stratton. *The last copepodid instar of* Diaptomus sanguineus *Forbes (Copepoda).* Journ. Washington Acad. Sci. **41**: 395–399, figs. 1–24. 1951.

Kiefer, Friedrich. *Zur Kenntnis der freilebenden Süsswassercopepoden, insbesondere der Cyclopiden Nordamerikas.* Zool. Jahrb. (Abt. Syst.) **61**: 579–620, 55 figs. 1931.

Light, S. F. *New American subgenera of* Diaptomus *Westwood (Copepoda, Calanoida).* Trans. Amer. Micr. Soc. **58**: 473–484, 24 figs. 1939.

Marsh, Charles Dwight. *A new crustacean,* Diaptomus virginiensis, *and a description of* Diaptomus tyrelli *Poppe.* Proc. U. S. Nat. Mus. **49**: 457–462, 7 figs. 1915.

———. *Distribution and key of the North American copepods of the genus* Diaptomus, *with the description of a new species.* Proc. U. S. Nat. Mus. **75**: 1–27, 16 figs. 1929.

Penn, George Henry. *Branchiopoda and Copepoda of the New Orleans area as recorded by Ed Foster in the early 1900's.* Proc. Louisiana Acad. Sci. **10**: 189–193. 1947.

Wilson, Mildred Stratton, and Light, S. F. *Description of a new species of diaptomid copepod from Oregon.* Trans. Amer. Micr. Soc. **70**: 25–30, figs. 1–11. 1951.

ICHTHYOLOGY.—*The blenniid fish genera* Cirripectus *and* Exallias *with descriptions of two new species from the tropical Pacific.*[1] DONALD W. STRASBURG, University of Hawaii, and LEONARD P. SCHULTZ, U. S. National Museum.

Schultz (Copeia 1941 (1): 17–20) recognized four species of *Cirripectus*, among which were *C. leopardus* and *C. brevis*. Chapman (*in* de Beaufort and Chapman, The fishes of the Indo-Australian Archipelago, **9:** 246–255. 1951) recognized three species of *Cirripectus*: *C. leopardus* (Day), *C. variolosus* (Cuvier and Valenciennes), and *C. sebae* (Cuvier and Valenciennes). In his discussion two extralimital species were recognized, *C. quagga* (Fowler and Ball) and *C. brevis* (Kner).

Further study of these species, based on many additional specimens, indicates conclusively that both Schultz and Chapman misinterpreted Kner's description and figure of *C. brevis*. We now find that *leopardus* must be referred to the synonymy of *brevis* and that the species distinguished by Schultz (l.c., p. 19) as *brevis* is a new species.

This contribution distinguishes as valid the genus *Exallias* and summarizes the chief differences between it and *Cirripectus*. Also two new species are described from the tropical Pacific. We do not consider this study as a review of the genera, since adequate material is not available. We lack specimens from the western Indian Ocean and from several island groups in the tropical Indo-Pacific Oceans.

The following analysis indicates the chief differences between *Cirripectus* and *Exallias*:

1*a*. A pair of barbels on underside of throat, each side of middle of chin; teeth in upper jaw very numerous, fine, flexible, those in lower jaw numerous, moderately flexible, about twice as broad as those in upper jaw and about one-third as many; no canines; least distance between eye and nuchal fringe contained 2½ or more times in postorbital length of head; soft rays of dorsal fin 12 or 13 and anal 14 or 15; upper lip with short barbels......*Exallias* Jordan and Evermann

1*b*. No barbels on underside of head; teeth in both jaws very numerous, fine, flexible, and of approximately same size; one or two canine teeth present at each side of lower jaw; least distance between eye and nuchal fringe contained fewer than two times in postorbital length of head; soft rays of dorsal 14 to 16 and of anal 15 to 17; upper lip crenulate or nearly so..............*Cirripectus* Swainson

Because *Exallias* has been confused with *Cirripectus* since it was proposed, a summary of the nomenclature for the two genera is important as well as that for the single species referable to *Exallias*.

Genus **Exallias** Jordan and Evermann

Exallias Jordan and Evermann, Bull. U. S. Fish Comm. **23** (for 1903): 503. 1905 (type, *Salarias brevis* Kner).

Gloriella Schultz, Copeia 1941(1): 17 (type, *Cirripectes caninus* Herre).

Exallias brevis (Kner)

Salarias brevis Kner, Sitz. Akad. Wiss. Natur. **58:** 42, pl. 6, fig. 18. 1868 (type locality, Savaii, Samoa); Weber, *Siboga* Exped. Fische: 537. 1913 (Karakelang Island).

Cirripectes brevis Fowler, Mem. B. P. Bishop Mus. **10:** 432. 1928 (Hawaii; Marshall Islands; Kingsmill Islands).

Salarias leopardus Day, Proc. Zool. Soc. London 1869: 518 (type locality, Ceylon).

Blennius leopardus Day, Fishes of India **2:** 325, pl. 68, fig. 5. 1876 (Ceylon).

Cirripectes leopardus Schultz, Copeia 1941(1): 19 (Oahu); U. S. Nat. Mus. Bull. 180: 272–273. 1943 (Oahu and Rose Islands); Chapman (*in* de Beaufort and Chapman) Fishes of the Indo-Australian Archipelago **9:** 247–249, fig. 43. 1951 (Moluccas, Talaut, Marshalls, Hawaiian and Samoan Islands).

Cirripectes caninus Herre, Philippine Journ. Sci. **59**(2): 284. 1936 (type locality, Ternate Island, Moluccas); **70**(4): 342. 1939 (Ternate Island).

Gloriella canina Schultz, Copeia 1941(1): 18 (Ternate Island).

Genus **Cirripectus** Swainson

Cirripectus Swainson, Nat. Hist. Fishes **2:** 79–80 (*Cirripectes* on pp. 182, 275) 1839 (type, *Salarias variolosus* Cuvier and Valenciennes); Norman, Ann. Mag. Nat. Hist. (11)**10**: 810. 1943; Chapman, Fishes of the Indo-Australian Archipelago **9:** 246. 1951.

Cirripectes Schultz, Copeia 1941(1): 18 (type, *Salarias variolosus* Cuvier and Valenciennes).

During the progress of this study numerous counts and measurements have been made on various species of *Cirripectus* and *Exallias*. These are recorded in Tables 1 to 3 and should be used along with the keys.

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[1] Contribution No. 28, Hawaii Marine Laboratory.

Our methods of counting fin rays and the number of cirri need describing. Each fin ray with a separate and distinct base was counted as one ray, those rays split to a single base were also counted as one. Females that are past the *Ophioblennius* stage have the first anal spine embedded in the tissue around the genital region. This spine was evident only by dissection. Sexually mature males have the distal part of the two anal spines developed into a knob, consisting of convoluted spongy tissue.

Each nuchal and supraorbital cirrus, including those forming double rows in certain cases, was counted as one cirrus if it had a single base; thus a cirrus deeply bifurcate distally or near its tip only was counted as one.

The problem of interpreting the significance of a single supraorbital cirrus must be considered on the basis of variability for each species. The supraorbital cirrus of *C. jenningsi* is simple, slender, and very, very rarely slightly bifurcate at its tip. This cirrus is never a broad flap as in certain other species. The supraorbital cirrus of *C. quagga* has a constricted base, thence broadening distally. It may be a simple dermal flap as in many young specimens, or the flap may be bifurcate or with multifid cirri in adults; the potential cirri in this species may appear as fleshy ridges in the dermal flap later becoming separated into distinct cirri.

In the young or juveniles of *C. sebae*, *C. variolosus*, and *C. filamentosus* the supraorbital cirrus occasionally may be simple but in the adults it is usually multifid.

The above discussion indicates that some caution must be used in connection with the supraorbital cirrus for distinguishing certain species. In faded and in young specimens, *jenningsi* and *quagga* may be confused but these two species may be distinguished respectively by the number of times the snout length is contained in the least distance from eye to nuchal fringe, which is 0.7 to 0.8, and 1.0 to 1.3, respectively (see the key).

Cirripectus filamentosus, based on specimens from Arnhem Land, Australia, might be considered as a subspecies of *C. variolosus* on the basis of slightly more numerous rays in dorsal and anal fins and fewer nuchal cirri, if both sexes of adult specimens of *filamentosus* did not possess an elongate first dorsal spine. In *variolosus* only the adult males have an elongate first dorsal spine. We do not have sufficient material from localities between the Marianas, Marshalls, Phoenix and Samoan Islands, and Australia to study this problem adequately.

The following key does not include the *Ophioblennius* stages of the genera *Cirripectus* and *Exallias*:

KEY TO THE PACIFIC SPECIES OF EXALLIAS AND CIRRIPECTUS

1*a*. Teeth in lower jaw fixed or barely movable and about half as numerous and twice as broad as those in upper jaw; no lower canines; chin with pair of barbels adjoining pair of pores on each side; length of snout into least distance from eye to nuchal fringe 0.3 to 0.5 times; dorsal rays XII, 12 or 13; anal II, 14 or 15 (rarely 15); nuchal cirri 30 to 36 (see table); edge of upper lip with 12 to 24 (usually 18 to 24) barbel-like lappets; color pattern of blackish spots on paler background. . . . . *Exallias brevis* (Kner)

1*b*. Teeth in lower jaw freely movable, of about same breadth and number as those in upper jaw; pair of lower canines present; chin without barbels; length of snout into least distance from eye to nuchal fringe 0.7 to 1.3; dorsal rays XII, 13 to 16 (rarely 13); anal II, 14 to 17 (rarely 14); edge of upper lip crenulate. . . . . (*Cirripectus* Swainson).

  2*a*. Body and pectoral fins everywhere covered with dark spots on paler background; nuchal cirri 47 to 62; dorsal rays XII, 14; anal II, 15. . *Cirripectus fuscoguttatus*, n. sp.

  2*b*. Body and pectoral fins not marked as in 2*a*; if dark spots are present they do not uniformly cover the body and pectoral fins; nuchal cirri 43 or fewer.

    3*a*. Anterior half of body pale, spotted with darker; posterior half of body blackish, spotted with pale; supraorbital cirrus slender and simple; dorsal rays XII, 15; anal II, 15 or 16 (rarely 15); length of snout into least distance from eye to nuchal fringe 0.7 to 0.8 times. *Cirripectus jenningsi* Schultz[2]

    3*b*. Color pattern not as in 3*a*.

      4*a*. Color of head and body plain tan to dark brown, sometimes with scattered pale spots or dots on snout, cheeks, and upper lip; fins brown to blackish except sometimes anterodorsal part of spinous and soft dorsals and upper lobe of caudal pale or whitish.

        5*a*. Nuchal cirri totaling 24 to 30 (see table); dorsal rays XII (very rarely XIII), 14 or 15; anal II, 15 or 16; first dorsal spine notably elongate

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[2] *Cirripectes jenningsi* Schultz, U. S. Nat. Mus. Bull. **180:** 273–275, fig. 27. 1943 (type locality, Swains Island).

in adults of both sexes as short as 45 mm. standard length.

Cirripectus filamentosus (Alleyne and Macleay)[3]

5*b*. Nuchal cirri totaling 29 to 37 (see table); dorsal rays XII, 14; anal II, 14 or 15; first dorsal spine elongate only in adult males.

Cirripectus variolosus (Cuvier and Valenciennes)[4]

4*b*. Head and body not colored as in 4*a*.

6*a*. Dorsal rays XII, 13 or 14; anal II, 14 or 15; background coloration light tan to dark brown. *Young*, longitudinal dark stripe from behind eye to caudal fin base, sometimes broken into series of elongate blotches. *Adults*, with 5 to 12 vertical dark brown bars; throat, cheeks, and opercles usually with numerous roundish pale spots, size of pupil, enclosed in reticulated brown lines that resemble a honeycomb, sometimes the brown pigment is so extensive that light spots appear on a dark background.

Cirripectus sebae (Cuvier and Valenciennes)[5]

6*b*. Dorsal rays XII, 13 to 16 (rarely 13, 14); anal II, 15 to 17 (rarely 15).

7*a*. Head and body tan to dark brown with 8 to 15 vertical dark bars and frequently speckled with tiny black and white dots; narrow dark bar below center of eye, another behind lower rear edge of eye, the latter extending across lip and meeting its fellow on underside of head; narrow transverse dark streak across gill membranes on underside of head; streaks may be diffuse on large specimens; nuchal cirri 25 to 36 (see table); length of snout into least distance from eye nuchal fringe 1.0 to 1.3 times.

Cirripectus quagga (Fowler and Ball)[6]

7*b*. Head and body dark brown or blackish; no vertical dark bars or streaks near eye or across gill membranes; color pattern consisting of conspicuous roundish pale spots, size of pupil, enclosed in reticulated brown lines that resemble a honeycomb, sometimes brown pigment is so extensive that light spots appear on a dark background; this pattern confined to throat, breast and sides of head in males but sometimes extending posteriorly as far as the fifth or sixth soft dorsal ray in females; large males have the posterior half to two-thirds of sides of body with numerous white markings that vary from round white dots or small spots to elongate ones or white lines that extend vertically, obliquely, or horizontally; some of elongate lines may run together; posteriorly both sexes may have scattered pupil-sized blackish spots or short lines on a dark background; nuchal cirri 32 to 42 (see table).

Cirripectus stigmaticus, n. sp.

Cirripectus fuscoguttatus, n. sp.

Fig. 1

Cirripectes brevis (non Kner), Schultz, Copeia 1941(1): 19–20; U. S. Nat. Mus. Bull. 180: 272–273. 1943 (Enderbury and Tutuila Islands); Chapman, Fishes of the Indo-Australian Archipelago **9**: 249 (note). 1951.

Holotype.—U.S.N.M. no. 113634. Rongerik Atoll, Eniwetak Island, Ocean reef in surf, June 29, 1946, S-46-241, Schultz and Herald, standard length 68 mm.

Paratypes (lots not bearing U.S.N.M. numbers have been distributed to other museums).—Bikini Atoll, Namu Island, Ocean reef, April 4, S-46-51, Schultz, 5 specimens 42 to 53 mm in standard length; Bikini Atoll, Bokon Island, April 15, S-46-94, Schultz and Brock, 9 specimens 34 to 80 mm; U.S.N.M. no. 142103, Bikini Atoll, Airy Island, April 16, S-46-96, Schultz, 16 specimens, 23.5 to 84 mm; U.S.N.M. no. 142102, Bikini Atoll, Eman Island, July 19, 1947, S-46-441, Schultz, Brock, Myers, and Hiatt, 10 specimens, 19 to 94 mm; Bikini Atoll halfway between Bikini and Amen Islands, July 21, 1947, S-46-442, Brock, Hiatt, and Schultz, 1 specimen; 72 mm; Bikini Atoll, Enyu Island, August 1, 1947, S-46-483, Schultz, Brock, and Hiatt, 2 specimens 73 to 76 mm; Bikini Atoll, Namu Island, August 6, 1947, S-46-508, Schultz, Brock, and Hiatt, 2 specimens, 91 to 95 mm; Bikini Atoll, Bikini Island, August 18, 1947, S-46-533, Brock and Schultz, 2 specimens, 93 to 99 mm; Bikini Atoll, Namu Island, August 7, 1947, S-1019, Brock, Hiatt, and Schultz, 2 specimens, 77 to 92 mm; U.S.N.M. no. 142106,

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[3] *Salarias filamentosus* Alleyne and Macleay, Proc. Linn. Soc. New South Wales **1**: 337, pl. 14, fig. 1. 1877 (type locality, Cape York).

[4] *Salarias variolosus* Cuvier and Valenciennes, Hist. Nat. Poiss. **11**: 317. 1836 (type locality, Guam).

[5] *Salarias sebae* Cuvier and Valenciennes, Hist. Nat. Poiss. **11**: 323. 1836 (type locality, East Indies).

[6] *Rupiscartes quagga* Fowler and Ball, Proc. Acad. Nat. Sci. Philadelphia **76**: 273. 1924 (type locality, Wake Island).

Rongerik Atoll, Eniwetok Island, June 29, S-46-241, Schultz and Herald, 12 specimens, 21 to 81 mm; U.S.N.M. no. 142104, Eniwetok Atoll, Mui Island, May 28, S-46-186, Schultz, 35 specimens, 22 to 100 mm; Eniwetok Atoll, Giriinien Island, May 29, S-46-187, Schultz, 1 specimen, 81 mm; U.S.N.M. no. 142105, Kwajalein Atoll, Ennylabegan Island, September 1, 1946, S-46-397, 1 specimen, 72 mm; U.S.N.M. no. 115497, Tutuila Island, Fagasa Bay, rock pools, June 5, 1939, Schultz, 1 specimen, 73 mm; U.S.N.M. no. 115498, Enderbury Island, reef, May 15 to 19, 1939, Schultz, 5 specimens, 73 to 89 mm; U.S.N.M. no. 164960, Gilbert Islands, Onotoa Atoll, July–August 1951, lagoon and ocean reefs, Randall and Strasburg, 2 specimens, 60 to 79 mm.

Description.—Certain counts were made of the holotype and paratypes and these data are

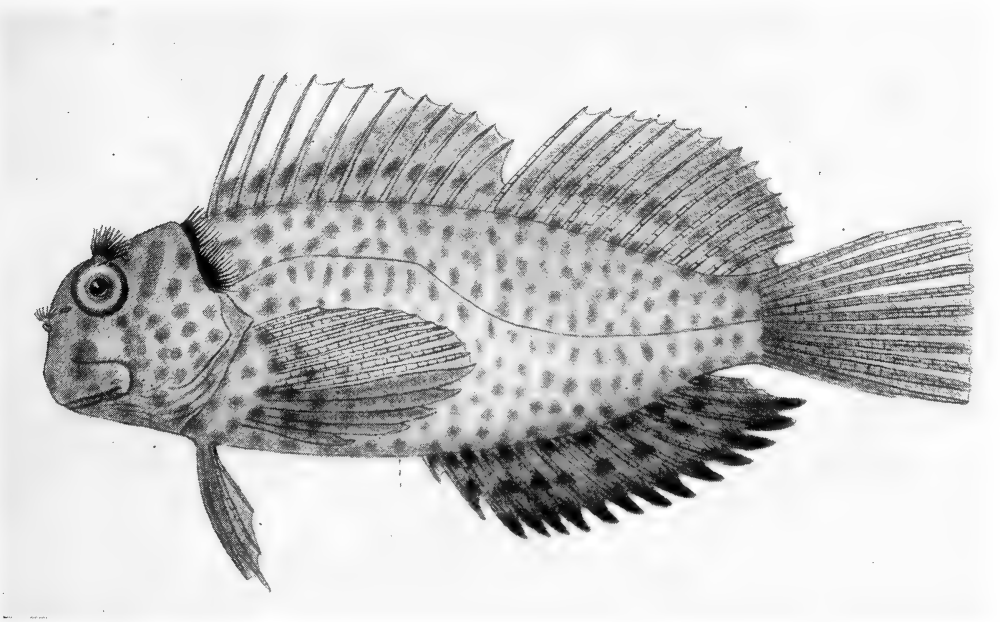

FIG. 1.—*Cirripectus fuscoguttatus*, n. sp.: Holotype (U.S.N.M. no. 113634), 68 mm. in standard length.

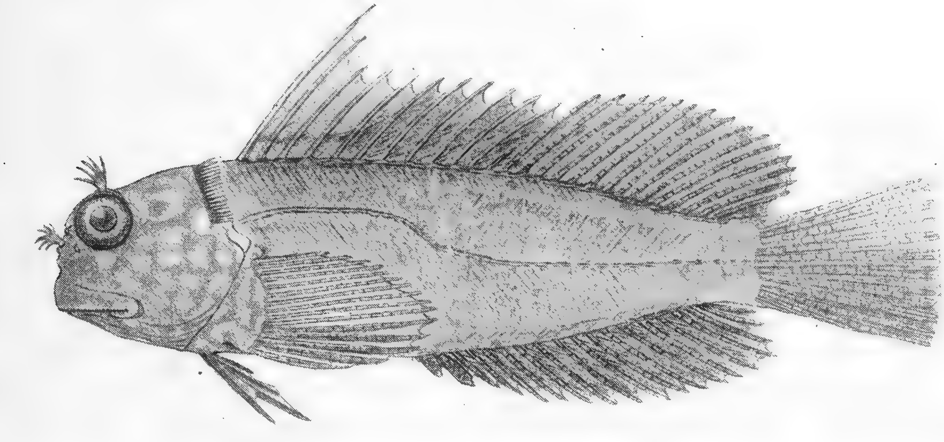

FIG. 2.—*Cirripectus stigmaticus*, n. sp.: Holotype (U.S.N.M. no. 164962), 63 mm. in standard length.

recorded in Table 1. Detailed measurements were made on the holotype, and these data, expressed in thousandths of the standard length, are recorded in Table 2.

Dorsal rays XII, 14; anal II, 15 (first anal spine embedded in females); pectoral 15 (with lower 5 or 6 thickened); pelvics I, 4; branched caudal rays 5 + 4; fringe of cirri on nape 47 to 62; nasal cirri 4 to 12, and orbital cirri 8 to 18 (more cirri on large adults). Head 3.0 to 3.2; greatest depth 3.2 to 3.5; longest dorsal spine 4.8 to 5.7; longest thickened pectoral ray 3.7 to 4.0; all in the standard length. Eye 3.0 to 5.0; snout 2.3 to 2.8; interorbital space 7.0 to 9.0; postorbital length of head 1.6 to 1.7; least depth of body 2.6 to 3.0; greatest depth of body 1.0 to 1.2; preorbital width 4.5 to 6.0; all in length of the head.

Orbital tentacle with a broad flattish base, its distal edge somewhat folded with numerous long cirri, more in adults; nuchal band of cirri simple, those at middorsal line about same length as those laterally, nuchal band of cirri curving posteroventrally so that the distance between vertical lines thru ventrolateral basal tip and anterodorsal edge is contained 4.6 to 5.6 times in postorbital length of head; ventral basal end of nuchal band of cirri blackish, notably swollen even in young, extending ventrally to opposite pupil; snout profile nearly vertical; edge of upper lip with numerous very short papillae or crenulate in young; lower lip shallowly plicate; no cirri on chin; lateral line arched over pectoral fin then curving to midlengthwise axis of body, ending at caudal fin base; a vertical line thru dorsal origin passes just behind lower tip of base of nuchal fringe and just behind pelvic bases; pectoral fin reaches a little past anal origin; anal spines two, first embedded in females, except juveniles; in adult males both anal spines with grayish crenulate and convoluted swollen dermal pads; a canine tooth present on each side of lower jaw; teeth in both jaws very numerous, of equal size, and moveable; sixth pectoral ray from lowermost edge of fin longest; distal edge of caudal fin a little rounded.

Color in alcohol.—Background color brown to light brown; body and head profusely covered with roundish black spots, usually absent from all fins except basally on pectorals; all fins very dark brown or blackish. The color pattern changes with size as follows: From 19 to 30 mm in standard length the black spots are barely discernible and few in number, the background color is chiefly plain brownish and dark and light bands on the head are becoming developed. In those 30 to 40 mm there is a prominent V-shaped brown mark on front of snout, which is separated by a narrow white band from next black band extending from below eye across upper lip to meet its fellow on chin, there forming a triangular spot; just behind this is a wide white band extending from behind eye across cheek through rear of maxillary meeting its fellow under head; this pale band set off sharply by dark brown color of rear of head. From 40 to 55 mm the large black spots on head and body are prominent, and the pale and dark bands on head are still discernible. Between the lengths of 55 to 70 mm, the black bands on head begin to break up into dark spots, and in those longer than 70 mm, the bands are no longer distinct having broken into roundish to oblong spots.

The nuchal fringe consists of black cirri, with a very blackish swollen basal area at lateral tips, even in the 19 mm specimen; the two anal spines on adult males have swollen dermal pads light grayish in color.

Color when alive.—Background color dark brown, spots blackish; eye crimson (iris); upper edge of caudal fin orange.

Ecology.—This moderately common species was taken in the Lithothamnium ridge area where the surf was strong.

Remarks.—The statement by Chapman (l.c., p. 249) that the two species "*leopardus*" and "*brevis*" (now *fuscoguttatus*) occur side by side in the Marshalls, Hawaii, and Samoa is incorrect. *C. fuscoguttatus* has not been collected in the Hawaiian Islands or at Johnston Island.

The key to the species of *Cirripectus* gives the essential characters and distinguishes *fuscoguttatus* from other related species in the genus.

Named *fuscoguttatus* in reference to the profusion of brown spots on body and fins.

Cirripectus stigmaticus, n. sp.

Fig. 2

Holotype.—U.S.N.M. no. 164962, Rongerik Atoll, Latoback Island, lagoon reef, June 28, 1946, S-46-238, Schultz and Herald, male, standard length 63 mm.

Paratypes.—U.S.N.M. no. 164963, Rongerik Atoll, Latoback Island, lagoon reef, June 28, 1946, S-46-238, Schultz and Herald, 2 specimens, 62 and 66 mm; U.S.N.M. no. 164964, Bikini Atoll, lagoon reef half way between Bikini and Amen Islands, July 21, 1947, S-46-442, Brock,

TABLE 1.—COUNTS RECORDED FOR SPECIES OF *Cirripectus* AND *Exallias* FROM THE MARSHALL, GILBERT, PHOENIX, AND SAMOAN ISLANDS.

Genus and species	Number of fin rays																Number of cirri																																						
	Dorsal							Anal					Pectoral				Nuchal																				Supraorbital																	
	XII	XIII	12	13	14	15	16	II	14	15	16	17	13	14	15	16	24 25	26 27	28 29	30 31	32 33	34 35	36 37	38 39	40 41	42 43	44 45	46 47	48 49	50 51	52 53	54 55	56 57	58 59	60 61	62 63	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Exallias brevis[1]	29	—	4	25	—	—	—	29	27	2	—	—	—	—	42	—				2	8	16	3																	2	6	5	14	4	14	6	4	1	1			1		
Cirripectus;																																																						
fuscoguttatus, n. sp.	26	—	—	—	26	—	—	26	—	26	—	—	—	—	41	—												2	1	6	9	5	1	1		2								2		1	2	3	7	8	2	3	1	3
variolosus	30	—	—	—	30	—	—	30	1	29	—	—	—	—	28	—			1	11	11	4	2														1		13	34	6	4		2										
sebae	85	—	—	2	83	—	—	85	2	83	—	—	—	4	108	8					3	11	24	24	16	7											3	11	26	38	45	31	12	4										
filamentosus[2]	34	1	—	—	10	25	—	35	—	9	26	—	2	5	61	2	7	18	8	2																	2	23	36	8	1													
jenningsi[3]	24	—	—	—	—	24	—	24	—	1	23	—	—	1	47	—		1				2	3	7	6	5											48																	
quagga[4]	29	—	—	1	1	27	—	29	—	3	24	1	—	2	49	—	1	4	5	12	5		1														16	11	14	12	3	1		1										
stigmaticus, n. sp.	28	—	—	—	1	26	1	28	—	1	27	—	—	3	42	1					1	5	8	8	4	2														8	15	21	7	3	1	1								

[1] These data include counts made on 15 specimens from Johnston Island and the Hawaiian Islands.

[2] All counts made on specimens from Arnhem Land, northern Australia.

[3] Not taken in the Marshall Islands.

[4] Two specimens from Wake Island included in the counts.

TABLE 2.—THE LENGTH OF THE SNOUT INTO THE LEAST DISTANCE BETWEEN HINDBORDER OF EYE AND NUCHAL FRINGE

Genus and species	Ratio										
	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3
Exallias brevis	2	10	1								
Cirripectus:											
fuscoguttatus, n. sp.					6	3		1			
variolosus							2	8	2		
sebae								10	2	1	
filamentosus								5	2	1	
jenningsi					4	5					
quagga								1	3	2	1
stigmaticus, n. sp.						2	6	2	1		

TABLE 3.—MEASUREMENTS, EXPRESSED IN THOUSANDTHS OF THE STANDARD LENGTH, MADE ON CERTAIN SPECIES OF CIRRIPECTUS

Characters	C. stigmaticus, n. sp.			C. fuscoguttatus, n. sp.		
	Holotype	Paratype	Paratype	Holotype	Paratype	Paratype
Standard length in millimeters	63.0	43.1	93.0	68	22	81
Head, tip of snout to rear of opercular membrane	291	309	291	316	332	321
Greatest depth of body	307	320	333	360	282	348
Least depth of body	113	114	116	129	109	123
Postorbital length of head	190	188	185	201	159	198
Diameter of eye	75	88	62	76	114	72
Snout tip or front of upper lip to eye	105	130	96	154	127	142
Fleshy interorbital space	30	23	38	37	41	37
Least distance from eye to nuchal fringe	114	97	104	106	109	107
Longest dorsal spine	289	241	190	210	154	216
Longest soft dorsal ray	217	218	202	225	173	216
Longest soft anal ray	156	144	165	206	141	183
Longest pectoral ray	252	262	215	313	259	284
Longest pelvic ray	181	200	174	235	218	198
Longest caudal ray	268	278	258	294	273	289
Snout tip to anus	510	534	556	486	559	518
Snout tip to dorsal origin	321	320	303	332	336	333
Length of anal fin base	413	410	468	404	382	251
Sex	♂	♂	♀	♀	—	♂

Hiatt, and Schultz, 2 specimens, 93 and 99.5 mm; U.S.N.M. no. 142129, Rongerik Atoll, Latoback Island, lagoon reef, August 14, 1947, Brock, Schultz, and Donaldson, 1 specimen, 82 mm; U.S.N.M. no. 164965, Apia, Samoa, Jordan and Kellogg, 1 specimen, 66.5 mm; U.S.N.M. no. 164961, Gilbert Islands, Onotoa Atoll, lagoon and ocean reefs, July–August 1951, John E. Randall and Donald W. Strasburg, 16 specimens, 36 to 76 mm; U.S.N.M. no. 154674, Marshall Islands, Arno Atoll, lagoon reef, June–September 1950, Donald W. Strasburg and Robert W. Hiatt, 3 specimens, 67 to 81 mm; U.S.N.M. no. 154673, Marshall Islands, Arno Atoll, ocean reef, June–September 1950, Donald W. Strasburg and Robert W. Hiatt, 2 specimens, 45 to 56 mm.

Description.—Certain counts are recorded in Table 1. Detailed measurements were made on the holotype and two paratypes, and these data are expressed in thousandths of the standard length in Table 3.

Dorsal rays XII, 14 to 16, rarely 14 or 16; anal II, 15 or 16, rarely 15 (first anal spine embedded on females); pectoral 14 to 16, rarely 14 or 16 (with lower 5 or 6 thickened); pelvics I, 4; branched caudal rays 5 + 4; fringe of cirri on nape 32 to 42, generally 35 to 42; nasal cirri 4 to 6; supraorbital cirri 4 to 10 (more cirri on large adults).

Head 2.9 to 3.1; greatest depth 3.1 to 3.3; longest dorsal spine (first) 1.9 to 2.9 (the first dorsal spine is elongate in adult males); longest thickened pectoral ray 2.1 to 2.6; all in the standard length. Eye 3.5 to 4.7; snout 2.4 to 3.1; interorbital space 7.7 to 13.3; postorbital length of head 1.5 to 1.7; least depth of body 2.5 to 3.0; greatest depth of body 0.87 to 0.96; all in the length of the head.

Orbital tentacle with a broad flattened base, its distal edge with numerous long cirri, more in adults; nuchal band of cirri simple, those at middorsal line about same length as those laterally, nuchal band of cirri curving posteroventrally so that the distance between vertical lines through ventrolateral basal tip and anterodorsal edge is contained 4.6 to 6.5 times in postorbital length of head; ventral basal end of nuchal band of cirri is notably swollen and flattened even in young; it is blackish and bears the lowermost 8 or 9 cirri, and extends ventrally to about upper edge of pupil; snout profile nearly vertical; edge of upper lip with numerous short papillae or crenulate in young; lower lip with mesial third smooth, lateral third on each side somewhat plicate; no cirri on chin; lateral line arched over pectoral fin then curving to midlengthwise axis of body, ending at caudal fin base; vertical line through dorsal origin passes just behind ventral tip of nuchal fringe base and just behind pelvic bases; pectoral fin reaches a little past anal origin; anal spines two, first embedded on females past the *Ophioblennius* stage, both free on males; adult males have crenulate and convoluted spongy masses on these spines; a canine tooth present on each side of lower jaw; teeth in both jaws very numerous, of about equal size in both jaws, and movable; fifth or sixth pectoral ray from lowermost edge of fin longest; distal edge of caudal fin a little rounded.

Color in alcohol.—Background color brown to blackish; vertical fins dark and unmarked except for anterodorsal part of the spinous dorsal, the distal tips of the first few soft dorsal rays, and the upper lobe of the caudal which may be pale or whitish; anal somewhat darker than body or other fins, pelvics dusky, pectorals dusky ventrally, paler dorsally.

The color pattern changes with size as follows: The smallest specimen available (35.8 mm in standard length) has the background color brown with the cheeks, opercles and sides of the body posteriorly to the tip of the depressed pectoral overlaid with round pale spots about the size of the pupil. Posterior to the pectoral tips these spots are enlarged so much that the surrounding brown areas have the appearance of irregular lines on a pale background. The vertical fins of this specimen are pale brown basally becoming almost transparent in their distal half to two-thirds. The spinous dorsal is marked with a dusky lengthwise stripe along its basal third; this demarks the distal pale area mentioned above.

In specimens above 40 mm in standard length the characteristic, although somewhat variable, adult color pattern has been attained. The roundish pupil-sized pale spots are much more distinct, sometimes they are enclosed in reticulated brown lines that resemble a honeycomb, and sometimes the brown pigment is so extensive that the spots appear to be on a dark background. The nuchal fringe consists of black cirri with a swollen, very blackish basal area laterally.

The distribution of the spots and other markings varies with sex as follows: *Males:* Spots on preorbitals and suborbitals, cheeks, opercles, entire underside of head and throat, and extending posteriorly on the pectoral bases. The posterior one-half to two-thirds of the sides of the body are covered with numerous white markings that may vary from round white dots or small spots to elongate ones or white lines that extend vertically, horizontally or obliquely; some of these lines may run together. There may be a few blackish pupil-sized dots or irregular markings on the sides of the caudal peduncle. The dermal pads on the anal spines of males are grayish to blackish in color. *Females:* Pale spots as in males; in addition they may extend as far posteriorly as the fifth or sixth dorsal soft ray. Posterior to this the spots give way to plain dark color or there may be irregular blackish dots or short lines on a dark background.

Color when alive.—Background color brown to blackish, anterior spots pale brown, sides of males covered with bright red dots or elongate spots or lines; anterodorsal tip of first and second dorsals and upper lobe of caudal reddish orange to white.

Ecology.—This rather uncommon species was taken in the Lithothamnium ridge area or areas of *Acropora* and *Pocillopora* corals where the surf was moderate to strong.

Remarks.—The key to the species *Cirripectus* distinguishes *stigmaticus* from all related species in the genus.

Named *stigmaticus* in reference to the white and dark spots.

Obituaries

Paul Ardeen Neal, medical director, United States Public Health Service, died on October 13, 1952, after a brief illness.

Dr. Neal, who was chief of the Laboratory of Physical Biology in the National Institutes of Health at the time of his death, entered the Public Health Service immediately after obtaining his medical degree from Vanderbilt University in 1927. He interned in U. S. Marine Hospital at New Orleans; received his Commission in the Service June 30, 1928; and during the following year was assigned to the Marine Hospital at Mobile, Ala.

From 1929 to 1933 Dr. Neal was attached to various United States Consulates abroad, in Ireland, Germany, Poland, Denmark, and Italy. He began his research career when, in 1934, he was assigned to the Division of Scientific Research to serve under Dr. R. R. Sayers in the Office of Industrial Hygiene and Sanitation. This marked the beginning of his active interest in the study of industrial poisons.

At the time the Division of Scientific Research was merged with the National Institute of Health (February 1, 1937), the Office of Industrial Hygiene became the Division of Industrial Hygiene, and Dr. Neal was placed in charge of the research laboratory of the division. When this laboratory became a separate organization within the National Institutes of Health, he continued as chief of the Laboratory of Physical Biology, the position he occupied until his death.

Dr. Neal was noted for his contributions to the field of industrial hygiene and was particularly interested in the fundamental processes involved in toxicology. Specific studies in mercury, manganese, and DDT poisoning were of critical importance to him. He was frequently called on by defense organizations and industry for consultation and assistance. In connection with the Model Safety Code for Industrial Establishments which was being prepared by the International Labor Office, Dr. Neal went to Geneva in the spring of 1949. In this year he was certified as specialist in Preventive Medicine and Public Health (Founders' Group) by the American Board of Preventive Medicine and Public Health. He was also a member of the Joint Subcommittee on Toxicity Screening Methods of the National Research Council Food Protection Committee, Subcommittee on Toxicology, and the Manufacturing Chemists' Association Committee on Chemicals in Foods.

Under Dr. Neal's direction the Laboratory of Physical Biology broadened its attack on fundamental biological problems to research in molecular biophysics, low energy and nuclear radiation biology, and physiological physics. He was author or joint author of more than 100 scientific articles.

He was a member of many scientific societies, notably the American Medical Association, American Public Health Association, American Association for the Advancement of Science, Washington Academy of Sciences, Association of Military Surgeons, American Industrial Hygiene Association, American Statistical Association, American Society of Human Genetics, and Society of Sigma Xi.

Dr. Neal was born in West Point, Tenn., on June 25, 1901. He is survived by his widow, Beatrice M. Neal, his stepson, Alasdair Munro, his two sons, Paul Whitaker and Robert Gordon Neal, his mother, Mrs. Madge Mae Neal, and his sister, Mrs. Ashley Pogue.

Miriam Lucile Bomhard, range conservationist, U. S. Forest Service, died at her home in Glenshaw, Pa., on December 16, 1952, after a lingering illness. Miss Bomhard was born in Bellevue, Ky., on July 24, 1898, the daughter of the Rev. W. A. Bomhard and Emma Koch Bomhard. The family moved to Pittsburgh in 1907 from Owensboro, Ky. Miss Bomhard graduated from Sharpsburg, Pa., High School in 1917 as valedictorian, entering the University of Pittsburgh in the fall of that year on an honor scholarship. She graduated therefrom in February 1921 with the B.S. degree *cum laude* and in June of the same year received the M.A. degree. One summer was spent at the Cold Springs Harbor, Long Island, Laboratory of Biological Research, and from 1921 to 1925, including summer sessions, she served first as graduate assistant and then as instructor in the botany department of the University of Pittsburgh, meanwhile pursuing postgraduate studies in both botany and zoology. From 1925 to 1926 she was engaged in research work in the Carnegie Museum Herbarium. In 1926 she received the Ph.D. degree from the University of Pittsburgh, the first woman to receive that degree from that university. Her doctorate thesis, which covered illustrations and keys on the identification of seeds of Allegheny County, Pa., plants, unfortunately was never published except in abstract form. In 1926 she was appointed instructor in biology in Newcomb College, the women's department of Tulane University, New Orleans, the first courses in zoology and botany at that college, and in 1927 was promoted to assistant professor, a position she occupied until 1932, when she resigned to go to Malaya and for a trip around the world. Returning to the United States in 1933, at a time when new teaching positions were scarce, she accepted an appointment as junior pathologist in the Bureau of Plant Industry, Washington, D. C., and, from 1934 to her death, was in research work in the Forest Service in what is now the Division of Dendrology and Range Forage Investigations.

Dr. Bomhard was a member of the American Association for the Advancement of Science, the American Society of Plant Taxonomists, the Botanical Society of America, the Botanical Society of Washington (corresponding secretary, 1940), the Ecological Society of America, the International Association for Plant Taxonomy, and the Washington Academy of Sciences. She was a cofounder of the New Orleans Society of Plant Sciences, of which she was secretary in 1930 and president in 1931; also an associate member of the Society of American Foresters. She was an authority on the taxonomy and ecology of United States range plants, especially of the Southeast, and on the taxonomy, distribution, and economic values of palms. Her interest in and knowledge of palms brought her inquiries from all over the world and from defense agencies and others in Washington concerned with important palm products. She served as taxonomist for the Vegetable Oil Mission of FAO in Venezuela in 1948. She was a contributor to the Forest Service *Range plant handbook* (1937) and, in connection with that work, developed a leaf-venation method of distinguishing the highly poisonous waterhemlock genus (*Cicuta*) from the superficially similar innocuous angelicas. Among her more important publications were *The wax palms* (1930), a series of articles on palms in the Louisiana Conservation Review (1937–1939), the palm list in *Standardized plant names* (1942), and *Palm trees in the United States* (1950); she was also coauthor of *Field book of forage plants on longleaf pine—bluestem ranges* of Louisiana (1952). During her earlier days she was a vocalist and sang on the radio. Because of her friendly, intelligent, and vivacious personality, wide travel and correspondence, and her services as guide to the A.A.A.S. meeting in New Orleans in 1931 for world scientists, Miss Bomhard had an enormous acquaintance, and her loss will be widely felt.

W. A. Dayton

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JOURNAL
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VOL. 43 May 1953 No. 5

PALEONTOLOGY.—*Some notes on the Pentameracea, including a description of one new genus and one new subfamily.* THOMAS W. AMSDEN, Johns Hopkins University. (Communicated by G. A. Cooper.)

The writer has recently been engaged in a study of the brachiopods belonging to the superfamily Pentameracea in preparation for the forthcoming *Treatise on invertebrate paleontology*. An investigation of the literature has shown that a new name is needed for the type species of *Gypidula* and that *Barrandella* Hall and Clarke is an objective synonym of *Antirhynchonella* Oehlert. In addition, a study of the collections at the U. S. National Museum has made it possible to add some further information on a previously described genus, *Platymerella* Foerste, and a previously described species, *Pentamerella areyi* (Hall and Clarke). A new genus, *Costistricklandia*, and a new subfamily, Pentameroidinae, are proposed in this report, and a brief discussion of the pentameroid classification, including a list of known genera, is given.

The writer is indebted to Dr. G. A. Cooper for permitting an examination of the collections of the U. S. National Museum and also for valuable suggestions and criticisms during the preparation of this manuscript.

There has been general unanimity of opinion among the different investigators of the Pentameracea on the importance of the brachial structures in the taxonomy of the group, but there has not been complete agreement on the names to be applied to such structures. The morphologic terms employed in this report (Fig. 1) are essentially the same as those used by Schuchert and Cooper in 1932. In their text figures 26–28 these authors illustrate two distinct types of structure in the brachial valve. One type, which is found in such genera as *Conchidium* and *Pentamerus,* shows each of the brachial plates to be tripartite, consisting of inner plates, brachial process, and outer plates with the last resting directly upon the floor of the valve; the second type, shown in the genus *Pentameroides,* is quadripartite, with each brachial plate composed of inner plate, brachial process, outer plate, and median septum. The writer believes that this terminology accurately describes the brachial structures of the Pentameracea with one exception: namely, the median septum of *Pentameroides* is thought to consist of two plates for which the name septal plates is employed (see discussion of Pentameroidinae).

Schuchert and Cooper applied these names consistently in their systematic descriptions of the various pentameroid genera. However, in their general discussion on the morphology of the Pentameracea (pp. 164–165) they did not use precisely this system but used a modification of Leidhold (1928, pp. 51–53). They state:

> The cardinalia of the Pentameridae are the most characteristic feature of the genera and probably of the family as well. These lamellae are divisible into four distinct units termed by Leidhold: (1) The inner crural plate, (2) the outer crural plate, (3) the crural band or border, (4) the septal plate. We prefer to term the first two of these parts simply the outer and inner plates, since we do not feel that it is at present certain that they are the homologues of the crura such as occur in the Rhynchonellacea and Terebratulacea.

For convenience in comparison, two illustrations of Leidhold are reproduced in Fig. 2.

This terminology of Leidhold does not appear to be entirely satisfactory. Although the writer has never examined a specimen of *Gypidula brevirostris,* it would appear from Leidhold's figure that the "Äussere Cruralplatte" and the "Cruralleiste" represent merely the posterior portion of the brachial process which in this genus is broad and bladelike (see Fig. 1, A). Furthermore, this author used a somewhat different system in describing the genus *Enantiosphen* (1928, pl. 5, fig. 3). The word "Cruralleiste" was dropped entirely, and "crus" was employed for the structure separating the "Innere Cruralplatte" and platte" and "Äussere Cruralplatte" (and extending on beyond these two plates). This usage fits in better with the known structure of the pentameroid brachiopods although the writer concurs with Schuchert and Cooper in their desire to drop the word crura in connection with the Pentameracea. It should be noted that the genus *Enantiosphen* is an unusual pentameroid brachiopod in that the brachial processes terminate in a loop, but at the posterior end the brachial plates which support these processes are pentameroid in their structure and are thought by the writer to exhibit some similarities with the genus *Penta-*

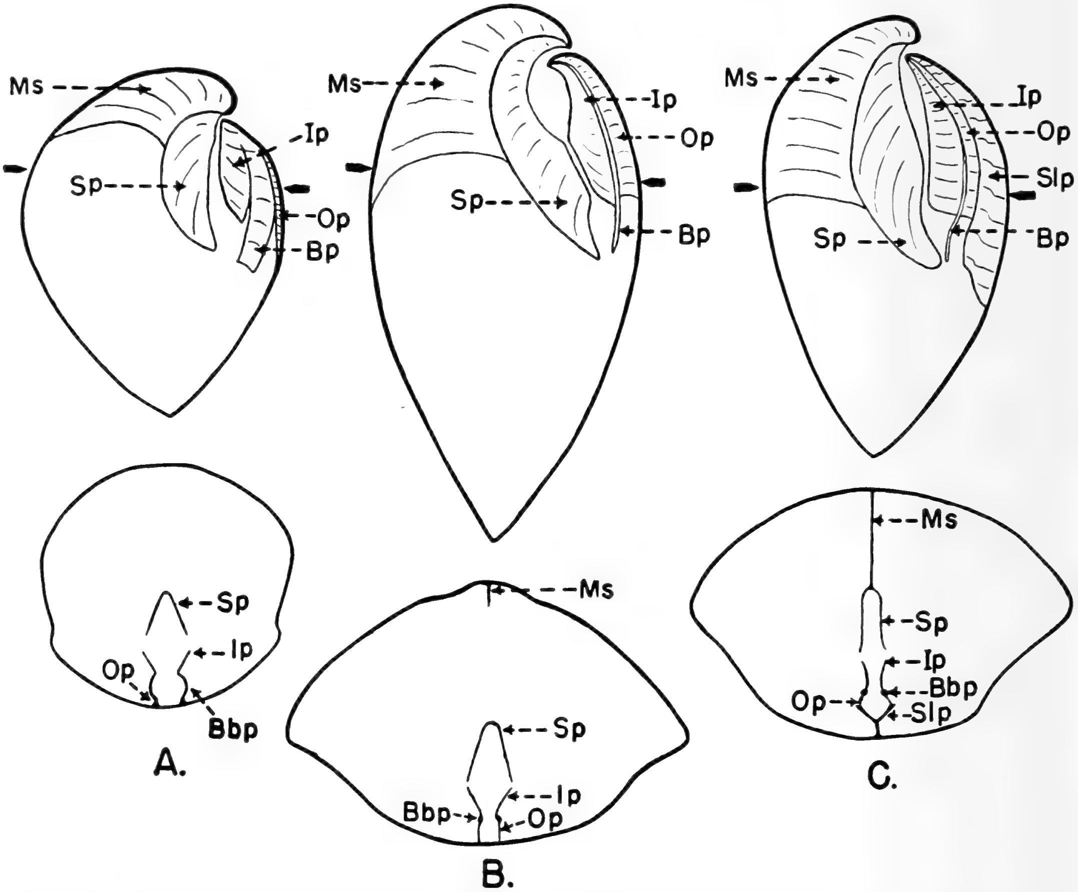

FIG. 1.—Longitudinal (above) and transverse (below) sections showing the internal structure of three subfamilies of the Pentameridae. Heavy, unlettered arrows on longitudinal sections indicate the position of the transverse sections. Transverse sections with pedicle valve above.

A. GYPIDULINAE. *Gypidula coeymanensis prognostica* Maynard. Silurian (Keyser), Keyser, W. Va.

B. PENTAMERINAE. *Pentamerus* cf. *P. oblongus* Sowerby. Silurian (Clinton), New York.

C. PENTAMEROIDINAE. *Pentameroides subrectus* (Hall and Clarke). Silurian (Niagaran), Jones County, Iowa.

Ms—Median septum
Sp—Spondylium
Ip—Inner plate
Bp—Brachial process
Bbp—Base of brachial process
Op—Outer plate
Slp—Septal plate

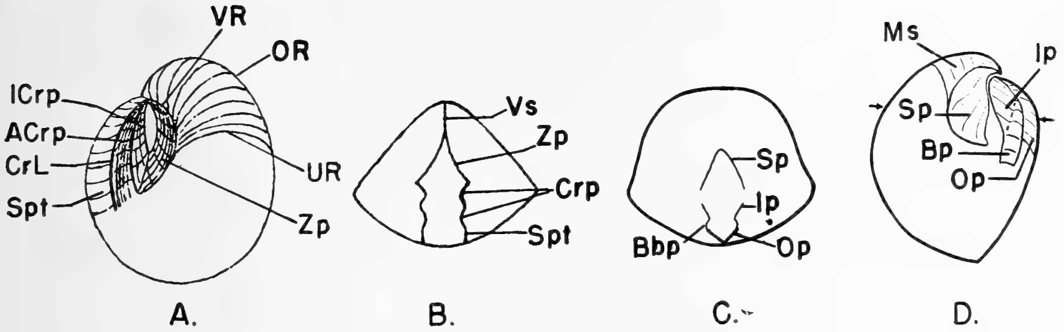

Fig. 2.—Comparison of the terminology used by Leidhold with that of the present paper:

A. Longitudinal section of *Gypidula brevi rostris* Phill. After Leidhold. VR—Vorderrand des ventralen Medianseptums; OR—Oberrand des ventralen Medianseptums; UR—Unterrand des ventralen Medianseptums; ZP—Zahnplatten, das Spondylium bildend; ICrp—Innere Cruralplatte [inner plate]; Acrp—Äussere Cruralplatte [base of brachial process]; Crl—Cruralleiste [junction of brachial process and outer plate]; Spt—Septalplatte [outer plate].

B. Transverse section of "*Pentamerella*" *sublinguifer* Maur. [*Clorinda? sublinguifer*]. After Leidhold. Vs—Ventrales Medianseptum [median septum]; Zp—Zahnplatten, das Spondylium bildend [spondylium]; Crp—Cruralplatten [inner plate plus base of brachial process]; Spt—Septalplatten [outer plate].

C and D. Transverse and longitudinal sections of *Sieberella roemeri* Hall and Clarke. Silurian (Brownsport), western Tennessee. Arrows on longitudinal section indicate position of transverse section; transverse section with pedicle valve above. Sp—spondylium; Ms—median septum; Ip—inner plate; Op—outer plate; Bp—brachial process; Bbp—base of brachial process.

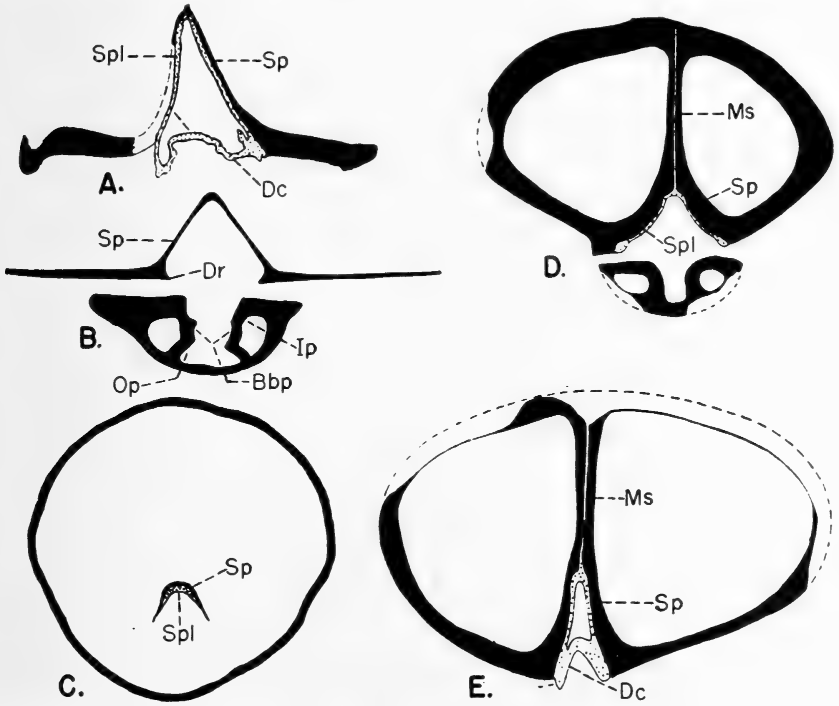

Fig. 3.—Sections showing structures of the pedicle valve. Figures A, B, D, E, after St. Joseph.

A. *Aliconchidium yassi* St. Joseph. Silurian (Hume series), New South Wales.
B. *Clorinda undata* (Sowerby). Silurian, Norway.
C. *Virgiana barrandei* (Billings). Silurian (Becsie River), Anticosti Island.
D. *Pentamerus borealis* (Eichwald). Silurian, Norway.
E. *Pentamerus* [?] cf. *P. gotlandicus* Lebedev. Silurian, Norway.

Bbp—Base brachial process
Dc—Deltidial cover
Dr—Delthyrial ridge
Ip—Inner plate
Ms—Median septum
Op—Outer plate
Sp—Spondylium
Spl—Spondylial lining

meroides. It seems desirable to keep the terminology applied to these two genera as nearly as possible in accord with that applied to other genera in this superfamily.

Accordingly the writer proposes to use the names as employed by Schuchert and Cooper in their text figures 26–28 (with the exception noted above) as being the method which most satisfactorily describes the morphology of this group; it also has the merit of being the system most widely accepted by writers since 1932. (See St. Joseph 1937, pp. 231–254).

The major structure of the pedicle valve is the spondylium which has been rather universally termed a spondylium duplex because of its two fold character. This spondylium duplex may be lined on the inside with a layer of shell material which is different in appearance from the outer wall (Fig. 3). St. Joseph (1937, pp. 240–248) has given a good description of this, finding it to be present in certain species of *Pentamerus, Conchidium, Stricklandia* and *Aliconchidium*. This spondylial lining varies in its thickness and in some specimens may extend downwards for some distance as a thin selvage which separates the two layers of the septum (Fig. 3, E). Kozlowski (1929, pp. 124–125, fig. 37) described a similar selvage of material in *Sieberella* cf. *galeata* and applied the name "lame intraseptale." The writer has seen a spondylial lining in specimens of *Costistricklandia gaspeensis* (Billings), *Virgiana barrandei* (Billings), *Brooksina alaskensis* Kirk, *Stricklandia* sp. and *Conchidium* sp.

St. Joseph (1937, pp. 231–240) noted that in certain specimens of *Pentamerus* the upper edge of this spondylial lining extended across the delthyrium, thus completely closing that opening at the posterior end (Fig. 3, E). This he called a pseudodeltidium and later found it to be also present in *Aliconchidium yassi* St. Joseph (Fig. 3, A).

Kozlowski (1929, p. 130) has also observed that certain species of *Conchidium* and *Pentamerus* may have the delthyrium completely closed by a plate, but he called this a syndeltarium and thought it was formed by the fusion of two plates. Schuchert and Cooper (1932, p. 163) recorded a somewhat similar covering in *Conchidium* and *Harpidium* which they preferred to designate by the noncommittal term, deltidial cover. At the present time it is not known how common a structure this is in the Pentameracea. It is apparently always very thin and delicate, and consequently could be easily destroyed; therefore, it may be more universally developed than present knowledge would indicate. Furthermore, the taxonomic significance of such delthyrial covering plates is uncertain at the present time and it would therefore seem advisable to use a noncommittal name such as deltidial cover rather than an expression which implies a homology with a structure in some other group of brachiopods.

There are some pentameroids in which the inner margins of the delthyrium show a thickening or callosity (Fig. 3, B). The significance attached to such structures has varied with different authors, just as it has with the deltidial covers. Hall and Clarke called them deltidial plates and used them to some extent in generic diagnosis whereas Kozlowski (1929, p. 130) applied the name deltarium discretum and considered them to be of ordinal rank. Schuchert and Cooper (1932, p. 163), on the other hand, did not attach much significance to them, noting that they do not close the delthyrium to any notable degree. Structures of this kind which the writer has observed seem to be primarily for the purpose of strengthening the shell margin rather than restricting the delthyrial opening.

SYSTEMATIC PALEONTOLOGY

Gypidula typicalis, n. name

Pentamerus occidentalis Hall, 1858, p. 514, pl. 6, fig. 2; non *Pentamerus occidentalis* Hall, 1852, p. 314.

The genolectotype (Oehlert, 1887, p. 1311) of *Gypidula* is *Pentamerus occidentalis* Hall, 1858, a name that is preoccupied by *Pentamerus occidentalis* (*Conchidium occidentale*) Hall, 1852. This homonym has been recognized for many years, but many of the earlier workers thought that *Pentamerus occidentalis* Hall, 1858, equaled *Atrypa comis* (*Gypidula comis*) Owen, 1852. Belanski (1928, pp. 8–9, pl. 2, figs. 1–8), who gave a good description and illustration of Hall's species, noted that there were valid specific differences between Owen's species and that of Hall but failed to give a new name to the latter. Therefore, it is here proposed that *Gypidula occidentalis* (*Pentamerus occidentalis* Hall, 1858, p. 514, pl. 6, fig. 2; non *Pentamerus occidentalis* Hall, 1852, p. 314) be named *Gypidula typicalis.*

Genus **Antirhynchonella** Oehlert, 1887

Antirhynchonella Oehlert, 1887 (*in* Fischer's Manuel de Conchyliologie, fasc. XI: 1311; non Quenstedt, 1871, pp. 231, 727).

Synonym: *Barrandella* Hall and Clarke, 1893 (pp. 241, 245).

Genotype: *Atrypa linguifera* Sowerby, 1839 (*in* Murchison's Silurian System, p. 629, pl. 13, fig. 8).

The status of the generic name *Antirhynchonella* has been in doubt for a number of years, although it has generally been credited to Quenstedt (type species, *tenuistriatus* Walmstedt) and suppressed as a synonym of *Conchidium.* The name was first used by Quenstedt (1871, p. 231) in the following manner:

> Aechte Pentameren haben entweder an der Stirn correspondirende Valven, oder Sinus und Wulst ist entgegengesetzt den Rhynchonellen, gleichsam Antirhynchonellen. Selbst die faustgrosse eiförmige tenuistriatus Walmst. auf Gothland, vom Habitus des glatten Esthonus (Eichwald Lethaea ross. I pag. 789) bewahrt diesen markirten Unterschied. Dagegen zeichnen die Engländer einen kleinen glatten Pentamerus linguifer Murch. Siluria 22.21 aus, der seine Zunge entgegengesetzt zur Bauchschale hinauf wendet.

In the index for this publication the name appears as *Antirhynchonella,* but it is not mentioned in the summary of genera and subgenera.

The next usage of the name is by Oehlert (1887, p. 1311), where it is given as *Antirhynchonella* Quenstedt; it appears as a "section" under *Conchidium* and is clearly used as a generic name. A diagnosis is given and the type is designated as *Atrypa linguifera* Murchison (both Quenstedt and Oehlert incorrectly give the author of *linguifera* as Murchison; it should be Sowerby in Murchison, Silurian System, p. 629, pl. 13, fig. 8).

Hall and Clarke (1894, footnote, p. 245) appear to have been in some doubt as to whether Quenstedt had used the name in a generic sense, pointing out that in the text he employed the name as simply the "Antirhynchonellas" and that it was only in the index that the latin form was applied. Although they were uncertain on this point, they apparently decided to accept it as a valid name but objected to Oehlert's type designation because, they state: "If any species can be taken as typical of ANTIRHYNCHONELLA, it is *Conchidium tenuistriatus,* Walmstedt, mentioned in immediate connection with the single use of this name, and not *Pentamerus linguifer* [a], which is cited by Quenstedt as an illustration of the fact that the position of the fold and sinus in the pentameroids is sometimes the same as in the Rhynchonellas." Hall and Clarke thought that the species *tenuistriatus* Walmstedt should be referred to the genus *Conchidium* and proposed to erect a new genus *Barrandella* for those pentameroid brachiopods having the structure of *linguifera* Sowerby.

Most later workers have followed Hall and Clarke in this interpretation, regarding *Barrandella* as a valid genus (*linguifera* as the type) and suppressing *Antirhynchonella* (*tenuistriatus* as type) as a synonym of *Conchidium* (Schuchert and Cooper, 1932, pp. 173, 181)

It appears to the present writer, however, that the manner in which the latin form *Antirhynchonella* was published in the index to Quenstedt's book cannot be regarded as acceptable.[1] In the first place there is no evidence that Quenstedt himself was responsible for the appearance of this name in the index to his book, it being just as probable that this entry in the index was due to a misreading of the text passage (p. 231) by another person who compiled the index. Second, even if Quenstedt himself compiled the index and was thus responsible for the appearance of the name *Antirhynchonella* on page 727, such a method of publication can not properly be held to have provided the name with an "indication" for the purpose of Article 25 (Proviso [a]) of the Rules. The name *Antirhynchonella* does not appear on the page cited in the index, the only reference on that page which can be held to have any connection with this subject is the vernacular word "Antirhynchonellen." But as long ago as 1907 the International Commission on Zoological Nomenclature ruled (Opinion 1) that a vernacular name is not to be accepted as an "indication." Therefore, the conclusion must be that even if Quenstedt did publish the generic name *Antirhynchonella* in his index it should be regarded as a nomen nudum.

Under these circumstances the name *Antirhynchonella* dates from Oehlert, 1887, with the type species *Atrypa linguifera* Sowerby, 1839, by

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[1] The writer is indebted to Francis Hemming, secretary of the International Commission on Zoological Nomenclature, for giving much information and help on this taxonomic problem.

original designation; accordingly *Barrandella* Hall and Clarke, 1894, becomes an objective synonym. It does not appear to the writer that the suppression of the name *Barrandella* will cause any great amount of confusion since the genus is not especially common nor does it affect any names above generic rank.

The writer has submitted the foregoing information to the International Commission on Zoological Nomenclature with a request that *Antirhynchonella* Quenstedt, 1871, be placed on the *Official index of rejected and invalid generic names in zoology* and that *Antirhynchonella* Oehlert, 1887, be placed on the *Official list of generic names in zoology*.

Platymerella manniensis Foerste

Fig. 4

Platymerella manniensis Foerste, 1909, pp. 70–71, pl. 1, figs. 1A–D; non *Platymerella manniensis* Foerste, 1920, pp. 223–224, pl. 23, figs. 5, A–H).

The genus *Platymerella* was proposed by Foerste in 1909, its description being based upon the single species *P. manniensis* from Silurian strata (Brassfield) at Riverside near Mannie, Tenn. It was distinguished largely upon such external characters as absence of a straight hinge margin, small, subequal beaks and nongaleatiform profile. Foerste noted that the pedicle valve had a short spondylium and septum but did not otherwise describe the internal structure. A few years later Foerste (1920, pp. 223–224), obtained some specimens from the Brassfield at Lawshe, Adams County, Ohio, which he considered conspecific with those from Tennessee. This material included some free interiors of both valves and on this evidence he enlarged his earlier definition and suggested that *Platymerella* was most closely related to *Pentamerella*. Foerste's illustrations of the brachial interiors of these Ohio specimens show two distinct types of structure: one shows parallel brachial plates (pl. 23, fig. 5H and ?5G) as in *Gypidula* whereas the other (pl. 23, fig. 5E, 5F) shows a small cruralium. In 1932 Schuchert and Cooper (pp. 184–185) reviewed this genus and referred it to the Pentamerinae rather than the Gypidulinae. They also noted this discrepancy in the nature of the brachial interior and suggested that Foerste may have illustrated specimens belonging to two different genera.

Dr. G. A. Cooper, of the U. S. National Museum, very kindly furnished the writer with a specimen of *P. manniensis* from the type locality at Mannie, Tenn., which was serially sectioned to show the internal characters. As is shown in Fig. 4, the brachial plates are extremely short with the inner plates extending forward about 3.5 mm and the brachial processes continuing on beyond this as slender, rodlike structures. It is not possible from the material at hand to tell whether the brachial processes are supported at their posterior end by outer plates or whether they attach directly to the valve. If outer plates are present, they are extremely short and are confined to the posterior tip of the shell. The pedicle valve has a thick-walled spondylium duplex which is supported for a short distance by a stout, double-walled septum.

The internal structure of *P. manniensis*, in particular the abbreviated brachial plates, seems to be most like that found in *Stricklandia* and *Costistricklandia*, and it is suggested that *Platymerella* be placed in the family *Stricklandidae*.

The writer has examined Foerste's figured specimens of "*Platymerella manniensis*" (1920, pl. 23, figs. 5A-H) from Adams County, Ohio, which are at the U. S. National Museum. The brachial valve shown in Fig. 5,H, is believed to be a member of the Gypidulinae, possibly belonging to the genus *Gypidula*; the specimen shown in 5G is probably the same with the forward portion of the plates broken away. The specimens shown in figures 5E and 5F are more difficult to place but are not believed to be con-

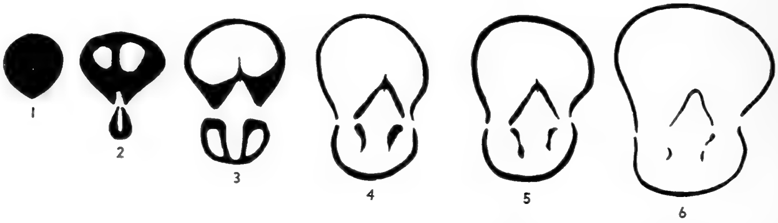

FIG. 4.—Serial sections of *Platymerella manniensis* Foerste (× 3). Silurian, Brassfield, Riverside near Mannie, Tenn. Peels of these sections at the U. S. National Museum. Pedicle valve above. Distance from posterior tip of pedicle beak: *1*—0.5 mm; *2*—1.2 mm; *3*—1.9 mm; *4*—2.1 mm; *5*—2.6 mm; *6*—3.3 mm.

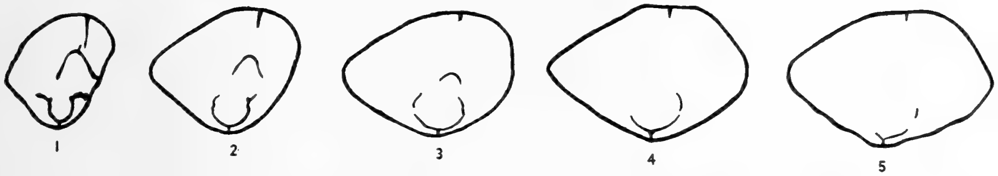

FIG. 5.—*Pentamerella areyi* (Hall and Clarke) (× 3). Irondequoit limestone, Clinton, N. Y. Peels of these sections at U. S. National Museum. Pedicle valve above. Distance from posterior tip of pedicle beak: *1*—2.5 mm; *2*—3.1 mm; *3*—4.0 mm; *4*—4.5 mm; *5*—4.9 mm.

generic with *P. manniensis* from Tennessee; they may be fragmentary individuals of a Gypidulinae, possibly *Sieberella*.

Pentamerella areyi (Hall and Clarke)

Fig. 5

Barrandella areyi Hall and Clarke, 1894, pp. 243, 368, pl. 71, figs. 14–16.

Hall and Clarke based this species upon specimens from the Clinton at Rochester, N. Y. In their description they covered only the external characters, no mention being made of the internal characters beyond noting that the pedicle valve had a well-developed spondylium. Through the courtesy fo Dr. G. A. Cooper, of the U. S. National Museum, the writer obtained a specimen of this species which was serially sectioned. As is shown in Fig. 5, *P. areyi* has a spondylium which is supported upon a fairly well-developed septum. The brachial valve has long, bladelike brachial processes which are supported upon outer plates that unite before reaching the floor of the valve. Inner plates are also present at the posterior end but these do not extend very far forward.

Hall and Clarke referred this species to *Barrandella* (=*Antirhynchonella*), but it differs from that genus in being multicostate. Its characters, both internal and external, are most like those of *Pentamerella*. *P. areyi* is considerably smaller than *P. arata* (genotype), but the external features are similar, both being multicostate and both having a brachial fold and pedicle sulcus. The brachial interiors are similar with the outer plates united to form a cruralium; in *P. areyi* these plates unite a short distance above the valve floor to form a double-walled septum. It is only in the pedicle valve that there are some slight differences; in *P. arata* the septum supporting the spondylium is very short whereas in *P. areyi* it extends forward as a complete plate for about a third the length of the valve and is continued beyond this as a ridge.

The reference of this species to *Pentamerella* is interesting because it greatly extends the known range of the genus. In 1932 Schuchert and Cooper (p. 176) gave the range as Middle and Upper Devonian. A few years later Khodalevich (1937, p. 68) described a species, *P. sosviensis*, from the Lower Devonian of the Urals. *P. areyi* extends the range back to the Middle Silurian.

Costistricklandia Amsden, n. gen.

Fig. 6

Genotype, *Stricklandia gaspéensis* Billings, 1859 (pp. 134–135; Hall and Clarke, 1894, pl. 73, fig. 11; Schuchert and Cooper, 1932, pl. 28, figs. 25, 27).

Description.—Shells variable in size but tending to be large with an oval or subcircular outline; hinge line straight, less than greatest width of shell; surface costate. Ventral interior with a spondylium duplex partially supported by a double-walled septum; spondylium usually of moderate length, extending a third or less the length of the valve; both spondylium and septum with thick walls. Brachial interior with long, rodlike brachial processes, which are unsupported by outer plates, their proximal ends attached to

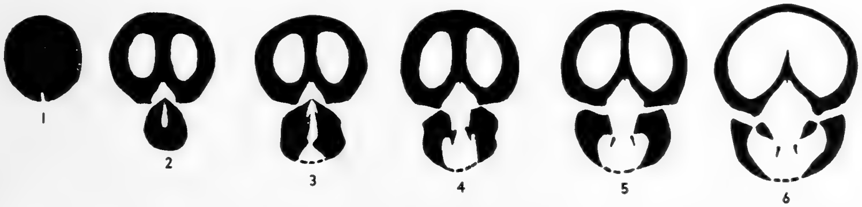

FIG. 6.—Serial sections of *Costistricklandia gaspéensis* (Billings). (× 1). Middle Silurian, La Vieille formation, Black Cape, Québec. Peels of these sections at the U. S. National Museum. Pedicle valve above. Distance from posterior tip of pedicle beak: *1*—0.9 mm; *2*—3.1 mm; *3*—3.6 mm; *4*—3.8 mm; *5*—4.5 mm; *6*—5.7 mm.

the posterior end of the valve; at the posterior end the brachial processes are directly overlain by outer plates which extend forward only a short distance.

Discussion.—In 1859 Billings (pp. 132–134) proposed the genus *Stricklandia*, including within it three English species, *Pentamerus lens* Sowerby, *Spirifer liratus* Sowerby, *Pentamerus laevis* Sowerby, and three Canadian species *Stricklandia gaspéensis* Billings, *S. canadensis* Billings and *S. brevis* Billings. No genotype was designated. A short time later, Billings (1863, p. 370) proposed to replace the name *Stricklandia* by *Stricklandinia* under the mistaken concept that his name *Stricklandia* was invalidated by prior usage for a plant. In 1887 Oehlert (p. 1310) selected *S. lens* as the genolectotype but almost all later workers have overlooked this and used Hall and Clarke's type designation of *S. gaspéensis* (1894, p. 251). Since Oehlert's designation clearly has priority over that of Hall and Clarke it must stand as the type.

The original description of *Stricklandia lens* (Sowerby in Murchison's Silurian System, 1839, p. 637, pl. 21, fig. 3) was based upon specimens from the Llandovery, Carmarthenshire, England. Recently St. Joseph (1937, pp. 323–330, text fig. 20–22, pls. 3, figs. 1–3, 7–9, 12–17; 4, figs. 12, 14; 8, figs. 10–19) has carefully redescribed this species, basing his description largely upon specimens from Norway although he also examined Sowerby's types. The internal characters appear to be very similar to those of *Costistricklandia gaspéensis*, with both species lacking outer plates; compare St. Joseph's text figures 20 and 21 to Fig. 6 of this report, and also his plate 8, figures 13 and 14, to plate 28, figure 25, of Schuchert and Cooper. The generic distinction between these two genera is based upon external characters, *Stricklandia* having a smooth shell and *Costistricklandia* being coarsely costate. They would seem to be closely related to one another and the difference between them is probably comparable to that separating *Pentamerus* from *Conchidium*.

PENTAMEROIDINAE Amsden, new subfamily

Description.—Rostrate, nongaleate Pentameridae. Pedicle interior with well-developed spondylium duplex. Brachial plates similar to the Pentamerinae but each plate consisting of four rather than three elements: inner plate, brachial process, outer plate, and septal plate.

A single genus, *Pentameroides* Schuchert and Cooper, is definitely referred to this subfamily. Two additional genera, *Pentamerifera* Khodalevich and *Conchidiella* Khodalevich, are provisionally included.

Discussion.—The genus *Pentameroides* was established by Schuchert and Cooper (1931, p. 248; 1932, p. 179) and included only one named species, *P. subrectus* (Hall and Clarke, 1894, p. 238, pl. 69, figs. 2, 3, 8–10), from the Silurian (Niagaran) of Jones County, Iowa. The writer has recently sectioned two specimens of the genotype which furnish details on the structure of this genus, in addition to the careful diagnosis given by Schuchert and Cooper. As is shown in Figs. 1C and 7, *Pentameroides subrectus* has a structure which is somewhat unusual for a pentameroid brachiopod. Each of the plates in the brachial valve consists of four elements: inner plate, brachial process, outer plate, and septal plate. These septal plates, which support the other elements, are discrete in their upper portion but unite with each other before reaching the floor of the valve, thus forming a double-walled septum. This structure and the terminology applied to it is similar to that used by Schuchert and Cooper (1932, text fig. 27) with this exception: These authors interpreted the outer plates as resting upon a single plate, the median septum, whereas the writer believes that the outer plates rest upon two plates, discrete at their junction with the outer plates, but coalescing before reaching the valve floor to make a double-walled septum. These are here called the septal plates. (Schuchert and Cooper call this the median septum in text fig. 27, but in the text, p. 165, they use septal plates.)

This structure is in contrast to the other subfamilies in the Pentameridae (Gypidulinae and Pentamerinae) where the brachial plates consist of three elements, inner plates, brachial processes and outer plates. In the Gypinulinae and Pentamerinae these outer plates may be discrete, or they may unit to form a cruralium, but in either case they rest directly upon the floor of the valve. A comparison of these different plate arrangements is shown in Fig. 1.

The terminology as herin used implies or suggests that the inner and outer plates of the Gypidulinae and Pentamerinae are homologous with the same named plates in the Pentameroidinae and that the septal plates of the latter are not developed in the other two subfamilies. Although such an interpretation is not unreasonable, it can not be regarded as proven at the present time.

It is interesting and perhaps significant to compare *Pentameroides* with the loop-bearing pentameroid brachiopod, *Enantiosphen* (Whidborne, 1893, p. 97). The writer has not had an opportunity to examine the internal characters of the latter, but Leidhold (1928, pp. 58–60, pl. 4, figs. 15, 16; pl. 5, figs. 1–3; Torley, 1934, pp. 93–96, pl. 5, figs. 9–10; Cloud, 1942, pp. 144–145, pl. 26, figs. 4–7) has given a good description based upon *E. vicaryi* (Davidson), from the Middle Devonian of Germany (the original description of this species was based upon specimens from the Middle Devonian of England). Leidhold describes the forward part of the brachial apparatus as consisting of four elements: Innere Cruralplatte, Crus, Äussere Cruralplatte, and Dorsales Medianseptum. The "crura" are overlain by the inner plates (Innere Cruralplatte) and underlain by the outer plates (Äussere Cruralplatte), the latter being supported by the median septum (Dorsal Medianseptum). The "crura" extend extend forward beyond the inner and outer plates to form a loop. This brachial structure, excluding the loop, is similar to that found in *Pentameroides*, a similarity that would be even more marked if the dorsal septum of *Enantiosphen* could be shown to consist of a double plate. It seems very possible that further studies of the genus *Enantiosphen* will show that the Enantiosphenidae and the Pentameroidinae are closely related.

St. Joseph (1937, pp. 286–292, pl. 5, figs. 7–8; pl. 6, figs. 13, 15; text figs. 1, 8) referred a species from the Silurian of southern Norway to *Pentameroides* (which he treated as a subgenus of *Pentamerus*). According to his description and illustrations of this species, *Pentamerus* (*Pentameroides*) cf. *gotlandicus* has a structure similar to that of a typical *Pentamerus* except the outer plates join just before reaching the floor of the valve. This author makes no mention of septal plates, nor do his illustrations show such a structure, and it therefore seems probable that the brachial plates of this species are not composed of 4 elements as they are in *Pentameroides*. *Pentamerus* (*Pentameroides*) cf. *gotlandicus* may represent a new genus which would have about the same structural relationship to *Pentamerus* that *Sieberella* has to *Gypidula* or that *Antirhynchonella* has to *Clorinda*. Since the writer has not examined specimens of the Norwegian species, it does not seem desirable to make such a generic distinction at this time.

In 1939 Khodalevich (pp. 96–97; pl. 14, figs.

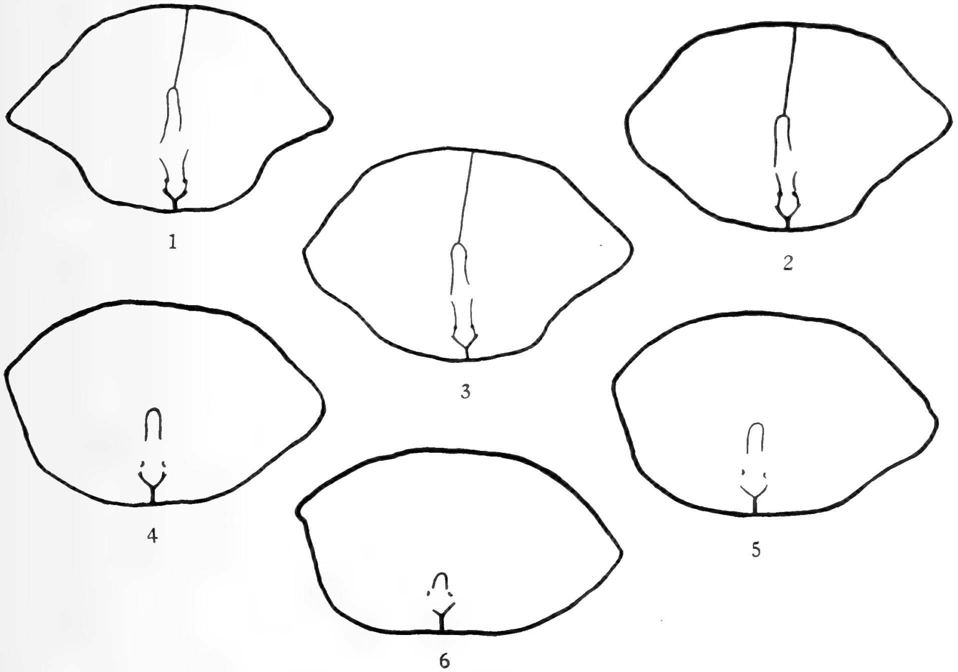

FIG. 7.—Serial sections of *Pentameroides subrectus* (Hall and Clarke). (× 1.5). Middle Silurian, Jones County, Iowa. Sections at the U. S. National Museum. Pedicle valve above. Distance from posterior tip of pedicle valve: *1*—13.5 mm; *2*—15.5 mm; *3*—16.8 mm; *4*—18.8 mm; *5*—19.5 mm; *6*—21.5 mm.

4a–4d; pl. 19, fig. 1) proposed a new genus, *Pentamerifera*, from the Upper Silurian of the Urals. This genus was described as being externally like *Pentamerus* and *Pentameroides*. The plates of the brachial interior were said to be discrete as in *Pentamerus*, but the structure of each of these plates was compared to *Pentameroides*, being divisible into inner, outer and septal plates with the brachial process lying between the outer and septal plates. Khodalevich was of the opinion that Schuchert and Cooper were in error when they described *Pentameroides* as having the brachial process between the inner and outer plates, believing that both *Pentamerifera* and *Pentameroides* had the brachial process between the outer and septal plates. The writer's studies of the type species of *Pentameroides* clearly indicates that Schuchert and Cooper placed the brachial process in the correct position. Therefore, on the basis of Khodalevich's description, the genus *Pentamerifera* would differ from *Pentameroides* not only in having discrete septal plates, but also in the position of the brachial process with respect to the other plate elements.

In this same paper, Khodalevich (1939, p. 100, text fig. 17) proposed a second pentameroid genus, *Conchidiella*. This was said to be internally like *Pentamerifera* but with external costae. This author figured several transverse sections of *Conchidiella* which show a structure which appears to have some similarities with the Gypidulinae. Since the writer has not had an opportunity to examine actual specimens of either genus, it is not possible to make any definite observations on the affinities of *Conchidiella* or *Pentamerifera*, but they may be provisionally placed in the Pentameroidinae.

CLASSIFICATION

In 1932 Schuchert and Cooper placed the following families in the superfamily Pentameracea: Camerellidae, Pentameridae, and Stricklandidae; the family Pentameridae was further divided into two subfamilies, the Gypidulinae and the Pentamerinae. A few years later Ulrich and Cooper (1938) removed the family Camerellidae to the Syntrophioidea, thus leaving only two families in the Pentameracea. The writer is in accord with this revision, but would suggest that the famlly Enantiosphenidae be included and that the new subfamily Pentameroidinae be added to the family Pentameridae. Following this modification in classification the superfamily Pentameracea, together with its families and subfamilies, may be diagnosed as follows:

Superfamily PENTAMERACEA. Shells variable in size but tending to be large; commonly strongly biconvex; exterior smooth, costellate, costate or rarely pitted. Pedicle interior with well developed spondylium duplex, usually supported on a double-walled septum, but in a few genera free. Lophophore supports consist of rod- or bladelike brachial processes; these processes unmodified except in the family Enantiosphenidae where they terminate in a loop; at the posterior end the brachial processes are supported on plates, usually extending forward sufficiently to enclose the brachial muscle field (Pentameridae, Enantiosphenidae) but which may be much shortened so as to exclude the muscle field (Stricklandidae). Impunctate.

FAMILY PENTAMERIDAE. Smooth, costellate or costate, rarely pitted, Pentameracea with well developed plates supporting the brachial processes; brachial plates may be discrete or may unite to form a cruralium, but in either case they always enclose the brachial muscle field.

SUBFAMILY GYPIDULINAE. More or less galeatiform Pentameridae, commonly strongly biconvex; fold and sulcus usually present; exterior smooth, multicostate, costate or pitted. Brachial apparatus tripartite, consisting of inner plates, brachial processes and outer plates; brachial processes broad and bladelike; outer plates discrete or coalesced to form a cruralium.

Subfamily PENTAMERINAE. Pentameridae of moderate to large size with smooth, costate or costellate exterior; fold and sulcus absent or poorly developed. Brachial apparatus tripartite, consisting of inner plates, brachial process and outer plates; brachial processes long and rodlike.

Subfamily PENTAMEROIDINAE. Pentameridae with the brachial plates quadripartite, consisting of inner plates, brachial processes, outer plates and septal plates; brachial processes rod-like.

Family STRICKLANDIDAE. Large, smooth or costate Pentameracea. Pedicle spondylium thick-walled, supporting septum thick, relatively short. Brachial apparatus with the outer plates much reduced or absent; brachial muscle field not enclosed by brachial plates.

Family ENANTIOSPHENIDAE. Specialized Pentameracea in which the brachial processes terminate in a loop; supporting plates quadripartite, consisting of inner plates, brachial processes, outer plates and ? median septum (or ? septal plates).

The following list includes all the pentameroid genera known to the writer at this time:

- Superfamily PENTAMERACEA Schuchert, 1896
  - Family Pentameridae McCoy 1844
    - Subfamily Gypidulinae Schuchert and LeVene, 1929
      - *Gypidula* Hall, 1867
      - *Sieberella* Oehlert, 1887
      - *Pentamerella* Hall, 1867
      - *Antirhynchonella* Oehlert, 1887 (syn. *Barrandella* Hall and Clarke).
      - *Clorinda* Barrande, 1879
      - *Salonia* Cooper and Whitcomb, 1933
      - *Wyella* Khodalevich, 1939
      - *Clorindina* Khodalevich, 1939
      - ? *Metacamerella* Reed, 1917
    - Subfamily Pentamerinae Waagen 1883
      - * *Pentamerus* J. Sowerby, 1813
      - * *Conchidium* Oehlert, 1887 [= *Conchidium* "Linnaeus" of Authors]
      - *Capelliniella* Strand, 1928
      - *Lissocoelina* Schuchert and Cooper, 1931
      - *Rhipidium* Schuchert and Cooper, 1931
      - *Harpidium* Kirk, 1925
      - *Brooksina* Kirk, 1922
      - *Cymbidium* Kirk, 1926
      - *Aliconchidium* St. Joseph, 1942
      - ? *Notoconchidium* Gill, 1951
      - ? *Zdimir* Barrande, 1881
    - Subfamily Pentameroidinae Amsden, new
      - *Pentameroides* Schuchert and Cooper, 1931
      - ? *Conchidiella* Khodalevich, 1939
      - ? *Pentamerifera* Khodalevich, 1939
  - Family Stricklandidae Hall and Clarke, 1894
    - *Stricklandia* Billings, 1859
    - *Costistricklandia* Amsden, n. gen.
    - *Platymerella* Foerste, 1909
    - *Holorhynchus* Kiaer, 1902
    - ? *Virgiana* Twenhofel, 1914
  - Family Enantiosphenidae Torley, 1934
    - *Enantiosphen* Whidborne, 1893

REFERENCES

Alexander, E. S. *Proposed use of the plenary powers to prevent the confusion which would result, under a strict application of the "Regles," from the sinking of the name* "Conchidium" *as a synonym of* "Pentamerus" *Sowerby 1813 (class Brachiopoda) and the transfer of the latter name to the genus now known as* "Conchidium." Bull. Zool. Nomencl. **2** (2). 1951.

Belanski, C. H. *Pentameracea of the Devonian of northern Iowa.* Univ. Iowa Stud. Nat. Hist. **12** (7). 1928.

Billings, E. *On some new genera and species of Brachiopoda from the Silurian and Devonian rocks of Canada:* Can. Nat. and Geol. **4.** 1859.

———. *On the genus* Stricklandia; *proposed alteration of the name.* Can. Nat. and Geol. **8.** 1863.

Cloud, P. E. *Terebratuloid Brachiopoda of the Silurian and Devonian.* Geol. Soc. Amer. Spec. Pap. 38. 1942.

Davidson, T. *British fossil Brachiopoda.* Pal. Soc. Mon. **5** (1). 1882.

Foerste, A. *Fossils from the Silurian formations of Tennessee, Indiana, and Illinois.* Bull. Denison Univ. Sci. Lab. **14.** 1909.

———. *The Kimmswick and Plattin Limestones of northeastern Missouri.* Bull. Denison Univ. Sci. Lab. **19.** 1920.

Hall, J. *Containing descriptions of the organic remains of the lower middle division of the New York System:* Paleontology of New York **2.** 1852.

———. *Paleontology of Iowa.* Geol. Surv. Iowa **1** (2). 1858.

Hall, J., and Clarke, J. M. *An introduction to the study of the genera of Paleozoic Brachiopoda.* Natural History of New York **8** (2). 1894.

Khodalevich, A. N. *The Lower Devonian of the Ivdel Region (eastern slope of the Ural).* Mat. Centr. Sci. Geol. Prosp. Inst. Palaeont. and Stratigr. **3.** 1937.

———. *Upper Silurian Brachiopoda of the eastern Urals.* Trans. Ural Geol. Service (Geol. Service of USSR). 1939.

Kozlowski, R. *Les brachiopodes Gothlandiens de la Podolie Polonaise:* Palaeont. Polonica **1.** 1929.

Leidhold, C. *Beitrag zur Kenntnis der Fauna des rheinischen Stringocephalenkalkes, insbesondere seiner Brachiopodenfauna:* Abh. Preussischen Geol. Landesanstalt **109** (1). 1928.

Oehlert, D. P. *Brachiopodes.* In Fischer's, *Manuel de Conchyliologie.* 1887.

Quenstedt, F. A. *Die Brachiopoden.* Petrefactenkunde Deutschlands **2.** 1871.

St. Joseph, J. K. S. *The Pentameracea of the Oslo region being a description of the Kiaer collection of pentamerids.* Norsk Geol. Tidsskr. **17.** 1937.

Schuchert, C., and Cooper, G. A. *Synopsis of the brachiopod genera of the suborders Orthoidea and Pentameroidea, with notes on the Telotremata.* Amer. Journ. Sci., ser. 5, **22.** 1931.

—————. *Brachiopod genera of the suborders Orthoidea and Pentameroidea.* Mem. Peabody Museum Nat. Hist., Yale Univ. **4** (1). 1932.

Sowerby, J. de C. *In* Murchison's *The Silurian system.* 1839.

Torley, K. *Die Brachiopoden des Massenkalkes der Oberen Givet-Stufe von Bilveringsen bei Iserlohn.* Abh. Senckenbergischen naturf. Ges. **43** (3). 1934.

Whidborne, G. F. *A monograph of the Devonian fauna of the south of England.* Pal. Soc. Mon. **2.** 1893.

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* The status of the generic names *Pentamerus* and *Conchidium* is uncertain. E. S. Alexander (1951) has submitted a petition to the International Zoological Commission on Nomenclature to have these names added to the official list of genera.

ENTOMOLOGY.—*Holarctic elements among the Ichneumoninae of Maine.* GERD H. HEINRICH, Dryden, Maine. (Communicated by A. B. Gurney.)

Until recently zoologists both of the United States and Europe have been strongly influenced by the belief that the New World was inhabited by a fauna totally different from that of the old Continent. The Palearctic and Nearctic subregions were considered as two clearly separated faunal regions. Slowly, however, the realization grew that this idea of the two worlds had to be modified, and science began the work of synthesis. It has become evident that besides the different endemic faunas of the northern parts of Eurasia and America there exists a rather considerable element of Holarctic species spread over the whole of the northern parts of both continents and that many species slightly different from one another in America and Eurasia have to be considered only as geographical subspecies of one and the same species. The purpose of this paper is to make a further contribution to our knowledge of such Holarctic elements.

In order to determine whether certain forms may belong together in the same species the consideration of biological facts and field observations seems to be not less important than the comparison of morphological characters; so I am using wherever possible the former as well as the latter for the following statements of Holarctic specific identities. I have not been able to find out in all cases whether the species identified below under the European names have already been described and recorded under American names. In other words, in some cases the synonymy remains unsettled. I am indebted to Prof. Henry K. Townes for the determination of the species described by Cresson and Provancher. I am unable to follow Townes in regard to the names of genera (Hymenoptera North of Mexico, 1951) because I acknowledge the decisions of the International Commission on Zoological Nomenclature which has ruled the names *Ichneumon*, *Pimpla*, *Ephialtes*, and *Cryptus* to be nomina conservanda.

Coelichneumon pumiliosimilis Heinrich ♀ ♂ (new record)

Orig. descr.: Bonner Zool. Beiträge 1951: 251. Described from northern Germany and the Alps.

The relatively small size, shape, and the particular type of coloration and proportions of joints of female antennae are identical with the type. Sides of scutellum white as is usual in the European males not only in the American male but also in all three American females (scutellum of the three known European females being entirely black). White marks of coxae I and II of the male larger than in European specimens.

2 ♀♀, 1 ♂ from Dryden, Maine, 1 ♀ from Carthage, Maine; ♀ ♂ compared with types.

Coelichneumon tauma Heinrich ♀ (new record)

Orig. descr.: Bonner Zool. Beiträge 1951: 253–254. Described from Austrian Alps.

Identical with type, even in such characters as the small white spots of the inner orbits on each side of the base of the antennae. Abdomen totally black, the brownish tint of segment 2–3 of the type evidently being accidental.

1 ♀ from Maine, bred from a pupa of Geometridae, by A. E. Brower; ♀ compared with type.

Coelichneumon calcatorius Thunberg (n. comb.) ♀ ♂ (new record)

Syn. *I. sylvanus* Holmgren.

White marks of inner orbits and upper margin of pronotum somewhat more extended than in my single European specimen (a female from Austrian Alps). Otherwise so identical that a subspecific separation does not seem to be possible.

1 ♀, 2 ♂♂ from Dryden, Maine; 2 ♂♂ from Maine, bred from *Olene* by A. E. Brower. (In spite of the identity of the shape of gastrocoeli with *Stenichneumon* Thomson this species does not fit into this genus in regard to the shape and areolation of propodeum. The new host record of Dr. A. E. Brower confirms this suggestion, because all typical species of the genus *Steinichneumon* Thomson are parasites of species of the genus *Plusia*.)

Stenichneumon militarius Thunberg subsp.? ♀ ♂

Females seem to be identical with European specimens.

The males which probably belong to them have antennae without white bands unlike the European males of the species. If this character should be proved to be constant the American population would have to be considered as a different subspecies though distinguishable only in the male sex.

♀ ♂ Dryden, Maine, ♂♂ Maine, bred from pupae of a *Plusia* species by A. E. Brower.

Stenichneumon culpator Schrank subsp. *cincticornis* Cresson, ♀ ♂ (n. comb., n. status)

Ichneumon cincticornis Cresson, 1864.

Sculpture, proportion of joints of female antennae, and whole morphology identical with the type form, especially in the unique character consisting of the peculiarly shaped tooth of coxae III of the female.

Subspecifically different by the constant black color of the whole abdomen in both sexes which however occurs occasionally also in the European subspecies (var. *ater* Berth.), and by the constant largely yellowish banded antennae of the male (the antennae of European males usually being entirely black, exceptionally only white banded).

Ichneumon sarcitorius Linnaeus subsp. ♀ ♂ (new record)

Males do not show any differences from the European specimens.

Females differ as follows: End of hind femorae not black, hind part of third segment not clear red but somewhat yellowish in tint (as in some Oriental subspecies of this species); the fourth segment with a whitish outer margin.

Open fields are the habitat of the American subspecies as well as of the European and Oriental.

This species is spread over the most part of the Northern Hemisphere and goes south in Asia into Northern Persia. It splits into several subspecies (cf. Heinrich, Mitt. Deutsch. Ent. Ges. II, 1931; 27–29).

The above described form from Maine belongs doubtless to the same species as *sarcitorius jucundus* Brullé, named in 1846 from a specimen from "South America" and since recorded from Kansas and other localities in the United States but not yet, as far as I know, from Maine. I hesitate, however, to use Brullé's name for the subspecies of *sarcitorius* Linnaeus recorded from Maine, because the single female collected there and described above differs definitely in color from typical females of *jucundus* from more southern localities. This difference, as soon as proved to be constant instead of individual only, will indicate another (northern) subspecies in a certain degree intermediate between the Eurasian subspecies of *sarcitorius* and *sarcitorius jucundus*.

1 ♀, numerous ♂♂ Dryden, Maine.

Ichneumon languidus Wesmael subsp. *bimembris* Provancher ♀ (h. status)

Identical in color and all other characters with European specimens except that the antennae are slightly more slender.

♀ ♀ Dryden, Maine.

Ichneumon nereni Thomson (= **raptorius** auct.) subsp. ♀ ♂ (new record)

Female.—Basal joints of antennae reddish, fifth segment not white marked. (This coloration is rather common also in European specimens.) Antennae somewhat more slender.

Males agree well with European.

♀ ♀ ♂ ♂ Dryden, Maine.

Ichneumon deliratorius Linnaeus subsp. *cinctitarsis* Provancher ♀ ♂ (n. status) (♀ a new record)

Female.—The particular type of coloration, scopula of coxae III and relatively deep gastrocoeli identical with European specimens. Proportions of segments of antennae similar, the latter however somewhat stouter in the American specimen.

Male.—Differs from European males in the partially white coxae and in the white annulus of each segment of tarsi III.

In contrast to the overwhelming majority of species of this genus the females of European *deliratorius* Linnaeus do not hibernate. Instead there are two generations, one in the spring, the second in the late fall. The American subspecies seem to show the same biological character; male and female were caught in the second half of September.

♀ ♂ Dryden, Maine.

Barichneumon anator Fabricius ♀ (new record)

Identical with the European specimens.

♀ Dryden, Maine.

Cratichneumon nigritarius Fabricius subsp. *acerbus* Cresson ♀ ♂ (n. status)

Female.—White marks of tibiae smaller, main color of legs darker, deep black.

Male.—Identical with the European specimens except that the white stripe of inner orbits is more often lacking.

Males of this species in Europe have a particular, typical smell which I used as the best character for quickly distinguishing them in the field from other similar species. The American males smell just the same. Subspecies *nigritarius* Fabricius as the typical parasite of *Bupalus piniarius* is found only in or near coniferous woods. Subspecies *acerbus* Cresson also seems to prefer coniferous woods but is not confined to them.

Limerodops fossorius Linnaeus subsp. *belangeri* Cresson ♀ (n. comb., n. status)
Amblyteles Belangeri Cresson. 1877.

The American subspecies differs from the European only slightly in the somewhat more extended black color of the end of hind tibiae, in the nearly entirely or entirely black antennae, the black scutellum and the somewhat smaller size. In the high mountain region of Bavarian Alps (Allgäu) I found however a specimen *fossorius* Linnaeus which agrees exactly in all these points with *belangeri* Cresson, except for the less extent of black color on the end of tibiae III.

At the time he described *belangeri,* Cresson was in doubt as to its generic position and stated in the original description that it "probably belongs to Wesmael's subgenus *Limerodes,*" which was my own former opinion about *fossorius* Linnaeus. The genus *Limerodops* Heinrich with the species *fossorius* Linnaeus as type was erected and described in Mitt. Münchener ent. Ges. **35–39:** 44-45. 1945–1949.

1 ♀ Dryden, Maine.

ENTOMOLOGY.—*A revision of the turtle bugs of North America (Hemiptera: Pentatomidae).* H. G. BARBER and R. I. SAILER, U. S. Bureau of Entomology and Plant Quarantine.

The group of insects commonly known as turtle bugs form the tribe Podopini of the pentatomid subfamily Graphosomatinae. This tribe is composed of a rather homogeneous assemblage of genera, which look very much unlike the genera now placed in the typical tribe of the subfamily. Much additional study will be required before the relationship exhibited by the Podopini and the Graphosomatini can be properly evaluated.

As the Podopini are now known, the tribe has almost world-wide distribution in the Temperate and Tropical Zones. The tribe attains its greatest diversity in the Ethiopian Region, where 9 of the 18 recognized genera are found. Including the new genus described in this paper, there are now 6 genera in the New World. Only 4 species are known from the Neotropical Region, and of these, only 2 belong to an exclusively Neotropical genus. It seems likely that this feeble representation in the Neotropical Region is the result of inadequate collecting; other wise the matter would be one of considerable zoogeographic interest.

So far as is known, all members of the tribe live in or near marshes among the roots of clumps of grass or sedge and under debris. They may also be found in similar environments along the margins of ponds, sloughs, and streams.

In addition to the material contained in the U. S. National Museum Collection (U. S. N. M.), and that contained in the senior author's personal collection, now deposited in the U. S. National Museum, many specimens were obtained through loan from the following institutions and individuals: University of Kansas Snow Museum (U. K. S. M.) through R. H. Beamer; Ohio State University Insect Collection (O. S. U. C.) through J. N. Knull; California Academy of Sciences (C. A. S.) through R. L. Usinger and E. P. Van Duzee; Mississippi Agricultural Experiment Station (M. A. E. S. C.); Patuxent Fish and Wildlife Research Refuge, through R. T. Mitchell; and the private collection of H. M. Harris, Ames, Iowa. All drawings were made by the junior author.

Tribe PODOPINI

1843. Podopides, Amyot et Serville; Hist. Nat. Insectes, Hemipteres: 56.
1851. Podopidae, Dallas; List Hempi. Ins. Brit. Mus., pt. 1: 51.
1859. Podopidae, Dohrn; Cat. Hemip.: 5.
1872. Pentatominae, Div. Podoparia, Stål, Öfv. Akad. Finska Vet. Soc. Förh. **29**: 34.

1884. Graphosomini, Tribe Podoparia, Jakovlev; Horae Soc. Ent. Ross. **18:** 204.
1893. Graphosomidae, Lethierry and Severin, Cat. Gen. Hemip. **1:** 49. (In part.)
1902. Graphosominae, Distant, Fauna Brit. India, Rhynch., **1:** 70. (In part.)
1904. Graphosomidae, Van Duzee, Trans. Amer. Ent. Soc. **30:** 21. (In part.)
1906. Graphosomatinae, Tribe Podoparia, Schouteden, Gen. Insectorum, fasc. 30: 28.
1908. Graphosomatinae, Bergroth, Mem. Soc. Ent. Belg. **15:** 145. (In part.)
1909. Pentatominae, Tribe Graphosomini, Kirkaldy, Cat. Hemip. **1:** 34, 222.
1912. Graphosominae, Tribe Podoparia, Oshanin, Kat. palä. Hemip.: 8.
1912. Graphosominae, Tribe Podopini, Zimmer, Contr. Univ. Nebraska Dept. Ent. no. 4: 20.
1915. Graphosomatinae, Tribe Podopini, Parshley, Psyche **22:** 171.
1917. Graphosomatinae, Tribe Podopini, Van Duzee, Cat. Hemip. N. Amer.: 25.
1919. Graphosomatinae, Hart, Bull. Illinois Nat. Hist. Surv. **13** (7): 166, 171.
1920. Graphosomatinae, Tribe Podopini, Stoner, Univ. Iowa Studies Nat. Hist. **8** (4): 48.
1923. Graphosomatinae, Tribe Podopini, Parshley, *in* Hemip. Connecticut: 754.
1926. Podopidae, Blatchley, Heterop. East. N. Amer.: 53.

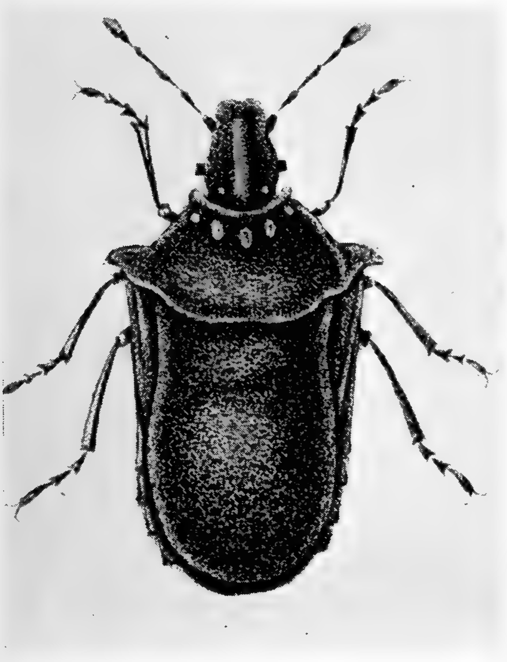


FIG. 1.—A photographic reproduction of Palisot de Beauvois's illustration of "Scutellera dubia," Insectes recueillis Afrique et en Amérique . . . pl. 5, fig. 6, 1805.

1939. Graphosomatinae, Tribe Podopini, Torre-Bueno, Ent. Amer. **19:** 197.
1945. Podopidae, Brues and Melander, Class. Insects: 150.

Characters of the tribe: Scutellum enlarged, U-shaped, covering most of the abdomen and membranous part of the corium, leaving exposed a short triangular clavus and rather narrow coriaceous part of corium, the latter attenuated posteriorly, apex often extended nearly to end of scutellum; frena very short, much less than one-third the length of sutellum. Eyes prominent, more or less pedunculate. Antenniferous tubercles produced, sometimes in part, at least, visible from above. Bucculae strongly elevated posteriorly. Pronotum transversely impressed near the middle; a distinct tooth or process before the rounded humeral margin; anterolateral margin either lobate, toothed, or with an elongate spinelike process; anterior disk within the cicatrices often with tuberclelike elevations. The media and subcosta of the hind wings nearly parallel at base; hamus absent. Odoriferous orifices set a little closer to the posterior coxae than to the lateral margin of the metapleura, devoid of gutters; the surrounding evaporating surfaces, roughly, irregularly corrugated. Spiracles situated much closer to the anterior than to the lateral margins of the segments. Trichobothria single, situated behind the spiracles and nearly on a line with them. Posterior lateral angles of the abdominal segments slightly nodoform.

Within the tribe there appears to be two easily recognized subdivisions. Male members of the genus *Podops* and at least three of the five New World genera (males of the remaining two not being available for study) have a movable appendage attached to the posterolateral angles of the hypopygium which is subsequently referred to as the hypopygial appendage. This appendage is known to be absent in *Scotinophara*, *Storthecoris*, *Melanophora* and *Aspidestrophus*.

KEY TO GENERA

1. Anterolateral margin of pronotum either with a subquadrate, denticulate lobe or an oblique cylindrical spine (see Figs. 2–4) 2
   Anterolateral margin of pronotum otherwise, usually with a more or less acute tooth (see Figs. 6, 10) 3
2. Anterolateral margin of pronotum with a subquadrate, denticulate lobe; juga inflated; pronotal cicatrices devoid of tubercles; devoid of a carina between the metasternal coxae .... *Oncozygia* Stål

Anterolateral margin of pronotum with a cylindrical spinelike process; juga flattened; anterior disk of pronotum with a tubercle in each cicatrix; a slight longitudinal carina between posterior coxae..*Notopodops*, n. gen.

3. Preocular margin of head with a small acute spine; juga flattened, extended to apex of tylus; cicatrices of pronotum devoid of tubercles; rostrum long, extended to venter; antenna 4-segmented......*Allopodops* Harris

Preocular margin of head devoid of a spine; juga flattened; cicatrices of pronotum bearing distinct tubercles; rostrum shorter, extended to intermediate coxae; antenna 5-segmented..............................4

4. Posterior coxae not contiguous, a short, metasternal sulcate carina between the coxae; juga much longer than tylus and contiguous before it; for the most part black *Weda* Schouteden

Posterior coxae contiguous or very nearly so, devoid of a metasternal sulcate carina; juga usually equally as long as the tylus or nearly so (except *brevitylus* and *vanduzeei*); fuscocinerous................*Amaurochrous* Stål

Genus **Oncozygia** Stål

Oncozygia Stål, 1872, Enum. Hemip. **2:** 15; Van Duzee, 1904, Trans. Amer. Ent. Soc. **30:** 21; Schouteden, 1906, Gen. Insectorum, fasc. 30: 29; Kirkaldy, 1909, Cat. Hemip. **1:** 231; Hart, 1919, Bull. Illinois Nat. Hist. Surv. **13** (7): 171; Blatchley, 1926, Heterop. East. N. Amer.: 54; Torre-Bueno, 1939, Ent. Amer. **19:** 197; 1940, Bull. Brooklyn Ent. Soc. **35:** 51.

Preocular part of head little wider than long; tylus very short, vertex raised above the level of the juga, the extended apices of which are tumidly elevated, obtuse and sometimes contiguous. Antenniferous tubercles obtuse, scarcely visible from above. Rostral sulcus deep. Antennae short, each terminal segment nearly as long as the preceding four segments combined. Thorax strongly narrowed anteriorly; obtusely impressed across the middle; anterior disk within the cicatrices devoid of tubercles; anterolateral margin with a large subquadrate, denticulate lobe which projects well beyond outer margin of eye; a short, acute tooth before the rounded humeral margin.

The serrately margined, membranous flap which is attached basally to the inner face of the clasper and extends palmately from the two arms seems characteristic of this genus (see Fig. 21).

Type, *O. clavicornis* Stål (only included species).

Oncozygia clavicornis Stål

Figs. 4, 18, 21, 22, 23

Oncozygia clavicornis Stål, 1872, Enum. Hemip. **2:** 15; Van Duzee, 1904, Trans. Amer. Ent. Soc. **30:** 23; Schouteden, 1906, Gen. Insectorum, fasc. 30: 30, pl. 3, fig. 12; Blatchley, 1926, Heterop. East. N. Amer.: 54; Torre-Bueno, 1939, Ent. Amer. **19:** 197.

Small, not over 5 mm long; black, shining, rather closely and coarsely punctate; covered with decurved, appressed, cereous, clavate, often abraded hairs. Rostrum short, extending just past anterior coxae.

Outline of head and pronotum as in Fig. 4.

Hypopygium, hypopygial appendage, claspers, and aedeagus as in Figs. 22, 23, 21, 18.

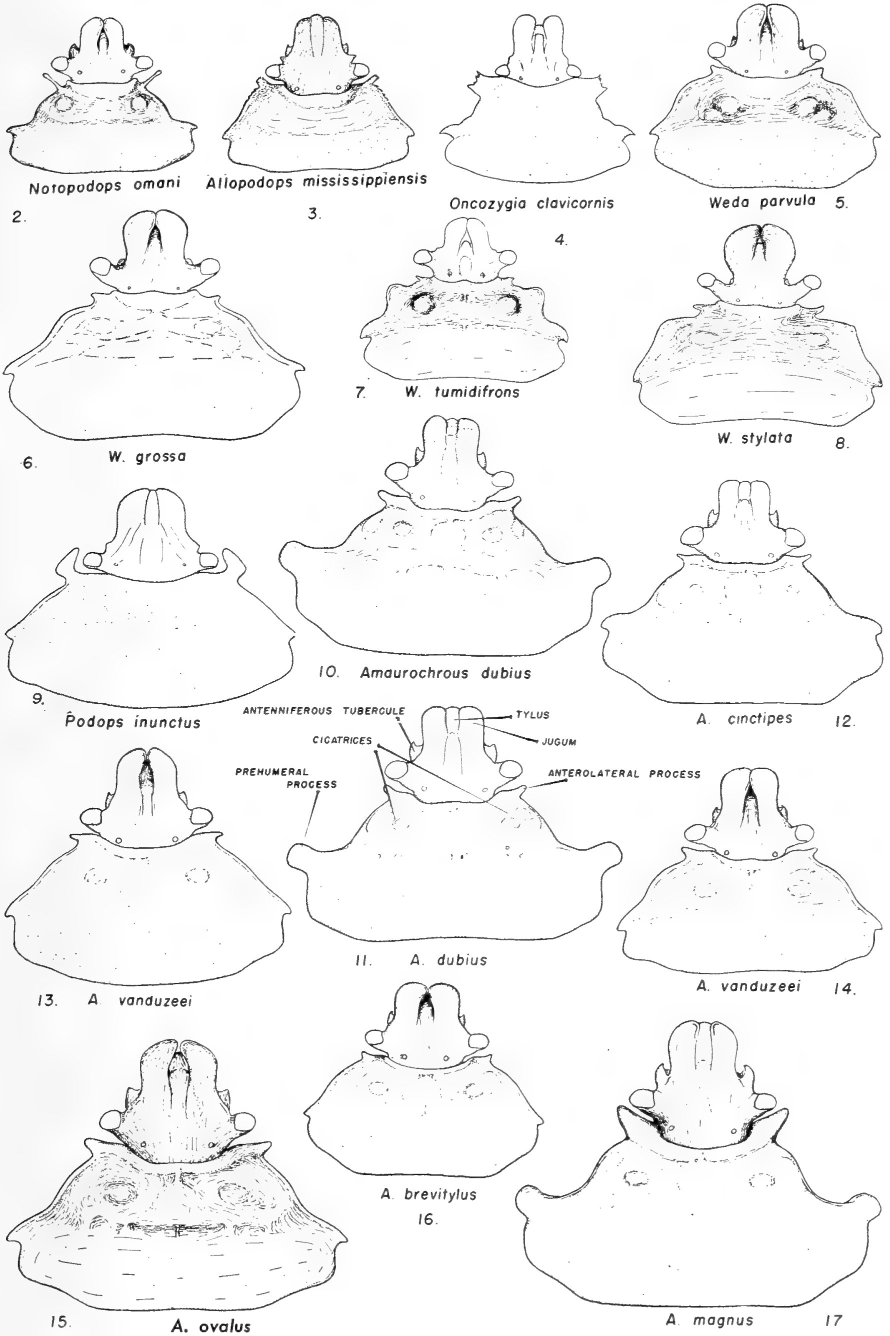
Stål described *clavicornis* from Texas. Since then it has been recorded from Fortress Monroe, Va., and from Ashby, Fla., by Torre-Bueno. The Vancouver, British Columbia, record cited by Hart is probably based on a misidentification.

Specimens have been examined from the following localities: *Virginia*: Fortress Monroe; *South Carolina*: Myrtle Beach (U.S.N.M.); *Florida*: Lake Placid (U.K.S.M.); *Mississippi*: Biloxi (M.A.E.S.C.), Wiggins (H. M. Harris Coll.); *Texas*: Galveston (U.S.N.M.), Gillespie County (O.S.U.C.).

O. clavicornis Barber (not Stål), 1906, was a mixed series one specimen of which is described under the following new genus.

Notopodops, n. gen.

Head much wider across eyes than long; eyes distinctly stylated; juga longer than tylus and contiguous before it; antenniferous tubercle with a prominent, stout, incurved, subacute process, this entirely visible from above; disk of vertex strongly elevated in a ridge which is continued anteriorly on the base of tylus, anteriorly, rather abruptly declivous. Antennae short, but little longer than the head. Rostrum short. Pronotum much wider than long, with two deep transverse impressions, the first somewhat remote from anterior margin, the second near the middle region, surface between these strongly elevated, more so in the center and provided on either side within the cicatrices with a prominent, rounded tubercle; lateral margins not explanate, lightly impressed for a short distance before the lateral sinus; just behind anterior angles armed with a slender, cylindrical, oblique, apically blunt process; prehumeral tooth not prominent. Outline of head and pronotum as shown in Fig. 2. Scutellum not twice as long as wide; surface deeply, obliquely impressed on each side from the basal angles. Connexivum narrowly exposed. Meta-



Figs. 2–17.—Dorsal views of the heads and pronota: 2, *Notopodops omani*, n. sp. (holotype); 3, *Allopodops mississippiensis* Harris and Johnston (Falls Church, Va.); 4, *Oncozygia clavicornis* Stål (Myrtle Beach, S. C.); 5, *Weda parvula* (Van Duzee) (Fort Collins, Colo.); 6, *W. grossa*, n. sp. (holotype); 7 *W. tumidifrons*, n. sp. (holotype); 8, *W. stylata*, n. sp. (holotype); 9, *Podops inunctus* (F.) (Toulouse, France); 10, *Amaurochrous dubius* (P. de B.) (Cuba); 11, *A. dubius* (P. de B.) (Lake Placid, Fla.); WITH PARTS COMMONLY MENTIONED IN DESCRIPTION LABELED; 12, *A. cinctipes* (Say) (Staten Islend, N. Y.); 13, *A. vanduzeei*, n. sp. (holotype); 14, *A. vanduzeei*, n. sp. (Los Angeles, Calif.); 15, *A. ovalis*, n. sp. (holotype); 16, *A. brevitylus*, n. sp. (holotype); 17, *A. magnus*, n. sp. (holotype). (All drawn to the same scale.)

sternum between the posterior coxae provided with a slight, longitudinal, nonsulcate carina. Legs short and stout.

Type: *Notopodops omani*, n. sp.

Notopodops is related to *Weda* and is chiefly distinguished by the nonexplanate lateral margins of the pronotum, the spinelike anterolateral process of the pronotum, short antennae, and the nonsulcate metasternal carina.

Notopodops omani, n. sp.

Fig. 2

Oncozygia clavicornis, Barber (not Stål), 1909, Sci. Bull. Mus. Brooklyn Inst. Arts, Sci. **1**: 256 (in part).

Length female, 4 mm. Dull black, arenose, narrow lateral margin of the scutellum, anteriorly and inner field of the corium, testaceous yellow; basal and terminal segments of the antennae fuscous, second, third, and fourth as well as most of the rostrum testaceous; legs fuscous, tibia in the middle region and the tarsi brown. Punctures on the dorsal and ventral surfaces rather fine and rather closely placed, each beset with a fine, short, cereous hair, in part forming incrustations; inner field of the corium more coarsely and sparsely punctate.

Head, one-fifth wider across eyes than long, somewhat declivous, lateral margins before the anterior, deflexed portion nearly parallel for some distance, thence abruptly rounded toward apices of juga which meet before apex of tylus; the acute process of the antenniferous tubercles extends anteriorly almost to middle of the preocular part of head. Antennae with the basal segment moderately incrassate, somewhat longer than the second and third combined, third and fourth subequal, terminal rather strongly incrassate, almost equal to the three preceding segments combined. Rostrum almost attaining middle point of the mesosternum. Pronotum nearly twice as wide across posterior lobe as long. Outline of head and pronotum as in Fig. 2. Scutellum nearly one-third longer than wide, margins parallel anteriorly for a short distance thence slightly expanded, widest across middle region; apex not quite reaching end of abdomen; disk at base somewhat elevated, followed posteriorly by a more or less distinct carina which becomes evanescent posteriorly. Connexivum narrowly exposed. Male unknown.

Holotype: Female, Boca Chica, Cameron County, *Texas*, May 30, 1933, P. W. Oman, U.S.N.M. type no. 61516. Paratype: Female, Esperanza Ranch, Brownsville, Tex., C. Schaeffer, from the senior author's collection.

Named in honor of Paul W. Oman, who has collected many interesting Hemiptera from the western States.

Genus **Allopodops** Harris and Johnston

Allopodops Harris and Johnston, 1936, Iowa State College Journ. Sci. **10**: 377; Torre-Bueno, 1940, Bull. Brooklyn Ent. Soc. **35**: 51, 52.

Obtuse apex of tylus extended slightly beyond apices of juga; eyes somewhat pedunculate; a small, acute marginal process just before the eye; antenniferous tubercles visible from above, very slightly produced outwardly. Antennae 4-segmented. Ocelli but little further apart than each is removed from an eye, set close to anterior margin of pronotum, well behind a line drawn across posterior margins of eyes. Rostrum long, extended on to the venter. Pronotum with the lateral margins nearly straight, anteriorly, finely serrate behind the sinuatotruncate process at the anterior angle; devoid of prominent tubercles within the cicatrices. Devoid of a metasternal carina between the coxae.

Type: *Allopodops mississippiensis* Harris and Johnston (only included species).

Allopodops mississippiensis Harris and Johnston

Fig. 3

Allopodops mississippiensis Harris and Johnston, 1936, Iowa State College Journ. Sci. **10**: 378, pl. 1; Torre-Bueno, 1940, Bull. Brooklyn Ent. Soc. **35**: 52.

Length 5 mm. Black, sparsely pilose. The small acute preocular process, position of the ocelli, 4-segmented antennae, longer rostrum and serrated lateral margins and the character of the anterior pronotal angles distinguish this species from any other member of the tribe. Outline of head and pronotum as in Fig. 3.

This species was described from a single female collected at Wiggins, Miss.

Two additional specimens have been found in the collection of the United States National Museum: A female from Jocassee, *South Carolina*, June 25, 1935, O. L. Cartwright, and a male (hypopygium missing) from Falls Church, *Virginia*, November 8, 1943, collected on sedge by F. Andre.

Genus **Weda** Schouteden

Weda Schouteden, 1905, Ann. Soc. Ent. Belg. **49**: 150; 1906, Gen. Insectorum, fasc. 30: 42; Bergroth, 1908, Mem. Soc. Ent. Belg. **15**: 147;

Hart, 1919, Bull. Illinois Nat. Hist. Surv. **13** (7): 171; Torre-Bueno, 1939, Ent. Amer. **19:** 197, 198; 1940, Bull. Brooklyn Ent. Soc. **35:** 51.

Most closely related to the genus *Amaurochrous.* It differs chiefly by the characteristic black coloration, juga longer than tylus and more contiguous anteriorly, lateral margins of pronotum usually more expanded and reflexed. Most notable difference is the presence of a sulcate metasternal carina between the hind coxae.

Type: (*Weda horvathi* Schouteden) = *Weda parvula* (Van Duzee) (only included species).

KEY TO SPECIES OF WEDA

1. Lateral margin of pronotum strongly lobate midway between anterolateral and prehumeral tooth. 2
   Lateral margin of pronotum not lobate, either gently, convexly rounded or obtusely angulated. 3
2. Lateral margin of head scarcely contracted before the eyes; juga narrowly contiguous before apex of the tylus, longitudinal ridge on the vertex and base of tylus strongly depressed in the middle. . .*tumidifrons*, n. sp.
   Lateral margin of head strongly contracted before the eyes; juga broadly contiguous before apex of tylus; longitudinal ridge on the vertex and base of tylus, viewed laterally, scarcely depressed in the middle. *stylata*, n. sp.
3. Head and pronotum subequal; lateral margins of head nearly straight and parallel; anterior and posterior lobes of pronotum subequally long; dull black; length 5 mm or less *parvula* (Van Duzee)
   Head much shorter than pronotum; lateral margins of head strongly contracted before eyes; anterior lobe of pronotum much shorter than posterior lobe; shining black; large species—6.40 mm. . . . .*grossa*, n. sp.

Weda parvula (Van Duzee), n. comb.
Figs. 5, 19, 24, 25, 26

Podops parvulus Van Duzee, 1904, Trans. Amer. Ent. Soc. **32:** 22 (part).
Weda horvathi Schouteden, 1905, Ann. Soc. Ent. Belg. **44:** 145; 1906, Gen. Insectorum, fasc. 30: 43; Bergroth, 1908, Mem. Soc. Ent. Belg. **15:** 147.

The following references to *parvulus* Van Duzee are erroneous and apply to *Amaurochrous brevitylus*, n. sp.:

Podops parvulus Van Duzee, 1904, Trans. Amer. Ent. Soc. **32:** 22 (part); Parshley, 1923, *in* Hemip. Connecticut: 755; Blatchley, 1926, Heterop. East. N. Amer.: 55–57; Torre-Bueno, 1939, Ent. Amer. **19:** 198.
Amaurochrous parvulus, Schouteden (not Van Duzee), 1906, Gen. Insectorum, fasc. 30: 33.

Length 5 mm. Dull black, densely punctate. Corium fuscotestaceous, very narrow margin of the connexivum, first three segments of antennae, rostrum and tarsi testaceous. Head nearly one-fourth wider across eyes than long; preocular lateral margins subparallel anteriorly; antenniferous tubercles slightly visible from above. Antennae with first, third, and fourth segments subequal, second segment shortest, somewhat shorter than basal, terminal segment but little shorter than the three preceding segments combined. Pronotum across humeral margins twice as wide as long; the acute process at anterior angle not extended beyond line of eyes; disk strongly, transversely impressed just before middle and also a little behind anterior margin; a distinctly elevated tubercle in each cicatrix; lateral margins lightly expanded, gently, convexly arcuate before the shallow, lateral sinus, thence very nearly straight to apex of acute prehumeral tooth, the latter extended but slightly beyond humeral margin. Outline of head and pronotum as in Fig. 5. Scutellum about one-third longer than wide, lateral margins nearly parallel anteriorly.

Hypopygium, hypopygial appendage, clasper and aedeagus as in Figs. 25, 26, 24, 19.

Podops parvulus Van Duzee, 1904, was described from a mixed series; however, the description was actually based on "a pair taken in Colorado." These have proved to belong to the species Schouteden described a year later as *horvathi* and which he made genotype of his new genus *Weda.* His specimens also came from Colorado. It therefore follows that *horvathi* Schouteden, 1905, must fall as a synonym of *parvulus* Van Duzee, 1904; however, *parvulus* must be transferred to Schouteden's genus *Weda.* The specimens from Montreal, Canada, Woods Hole, Mass., and Lawrence, Kans., which were also identified by Van Duzee as *parvulus,* belong to the genus *Amaurochrous* and must be described as a new species (see *A. brevitylus*, n. sp.). Schouteden's excellent figure, plate 3, figure 13, in the Genera Insectorum, mistakenly identified as *parvulus* Van Duzee, also pertains to this same new species of *Amaurochrous.*

A specimen belonging to the E. P. Van Duzee Collection, now deposited in the California Academy of Sciences, has been designated lectotype. It is a female labeled "*Podops parvula* Van Duzee, from Col. No. 238." Other specimens examined include 3 labeled "Col."; 2, Fort Collins, and 2

Manzanola, *Colorado* (in Colorado Exp. Stat. Coll.); 2, "Col.," No. 238 (Osborn Coll., deposited in A.S.U.C.); 2, Fort Collins, Colo., and 1 from Brigham, *Utah* (U.S.N.M.).

Weda tumidifrons, n. sp.

Figs. 7, 30, 31, 32

Oncozygia clavicornis, Barber (not Stål), 1906, Sci. Bull. Mus. Brooklyn Inst. Arts, Sci. **1:** 256 (in part).

Length 4 mm. Somewhat smaller than the two preceding species but of the same general fuscous coloration; corium testaceous. Head nearly one-fourth wider than long; lateral margins gently diverging before the strongly stylated eyes; antenniferous tubercles but very slightly visible from above; seen from the side, strongly elevated on the vertex and on the base of the tylus, lightly depressed between the two tumid-like elevations. Antennae as long as width of head across eyes, basal segment twice as long as second, a little longer than third, fourth one-fifth shorter than third and the terminal equal to the three preceding segments united. Apex of rostrum reaching to middle point of the intermediate coxae. Pronotum almost twice as wide across posterior lobe as long; acute process at anterior angle quite short, not extending outward as far as outer margin of eye; disk strongly impressed across the middle, anterior transverse impressions shallow, set closer to anterior margin than in *parvula*; tubercles in the cicatrices strongly elevated; expanded lateral margin anteriorly, strongly, convexly arcuate, sublobate before the lateral sinus; prehumeral tooth subacute, projecting a little beyond the humeral margin. Outline of head and pronotum as in Fig. 7.

Hypopygium, hypopygial appendage, and clasper as in Figs. 31, 32, 30.

Holotype: Male, Plano, *Texas*, July 1907, E. S. Tucker, U.S.N.M. type no. 61517. Paratypes: *Texas*: male, Esperanza Ranch, Brownsville, C. Schaeffer; male and female, College Station, April 8, 1928, H. G. Johnston; and May 20, 1928, J. C. Gaines; female, College Station, July 19, 1932, J. C. Gaines; *Colorado*: Boulder, November 5, 22, R. Shotwell; from the senior author's collection.

Distinguished from the preceding species by the two tumidescent elevations on the head and the sublobate anterolateral margin of the pronotum.

Weda stylata, n. sp.

Figs. 8, 27, 28, 29

Length 5.45 mm. Fuscous; coloration of parts much the same as in the three preceding species. Head a little wider than long; lateral margins before the strongly stylated eyes somewhat flaring anteriorly; preocular part of head half as long as entire head; antenniferous tubercles scarcely visible from above. Antennae but little longer than width of head; second segment about one-third shorter than basal, third one-fourth shorter than second, fourth but little shorter than third and the terminal somewhat shorter than the three preceding segments united. Apex of rostrum reaches to intermediate coxae. Pronotum not nearly twice as wide across posterior lobe as long; acute process at anterior angle extending outwardly but little beyond outer margin of eye; disk transversely impressed a little before the middle; anterior impression forming a shallow gutter; the anterior margin somewhat reflexed; expanded lateral margins before the sinus very strongly convexed, or obtusely angled, thence slightly, concavely arcuated opposite the median transverse impression; prehumeral process obtuse, projecting but slightly beyond the humeral margin. Outline of head and pronotum as in figure 8. Scutellum almost one-third longer than wide, obsoletely, longitudinally carinate in the middle.

Hypopygium, hypopygial appendage, and clasper as in Figs. 28, 29, 27.

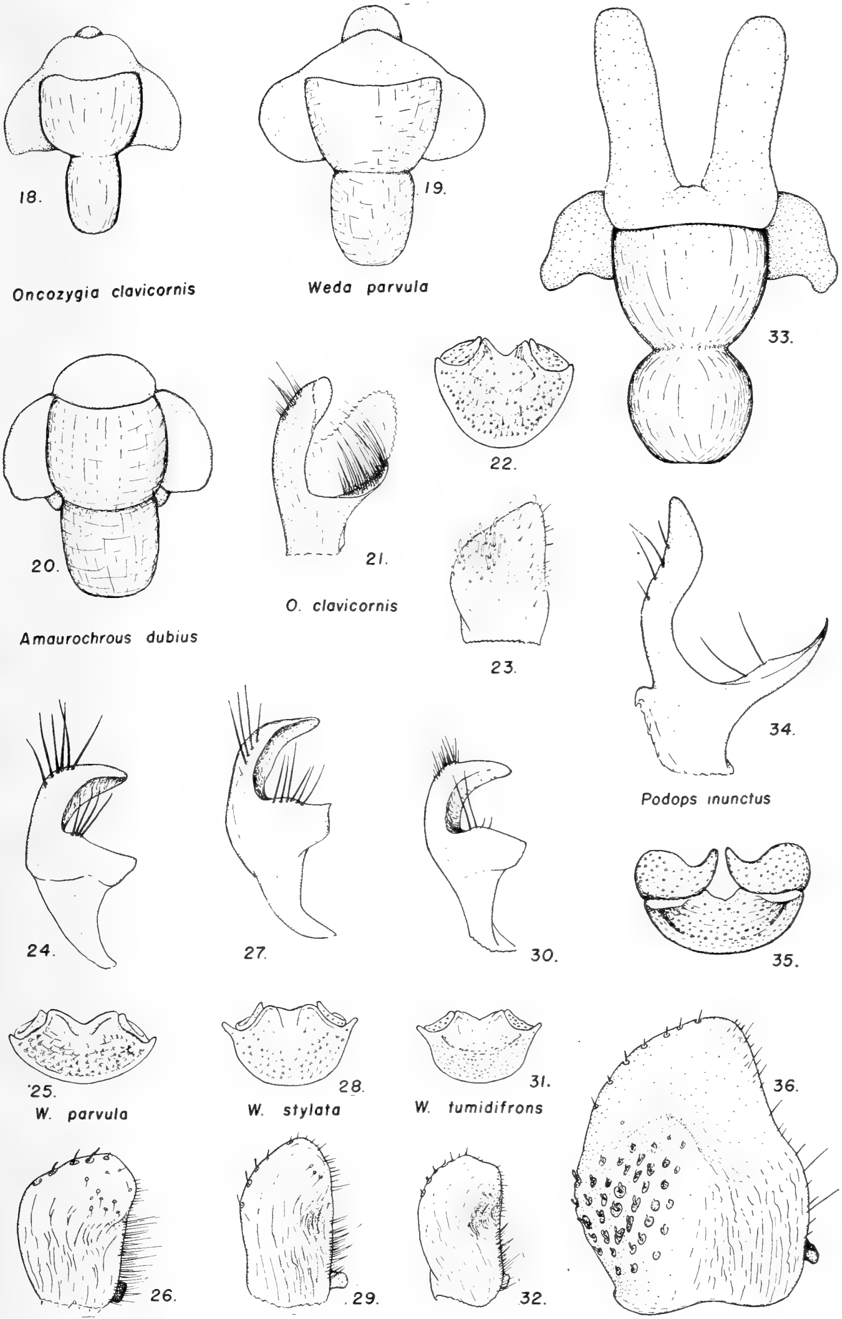
Holotype: Male, Salton, *California*, March 29, H. G. Hubbard, and paratype male from the same locality, March 26 (U.S.N.M. type no. 61518); paratype female, Coachella, Calif., May 21, 1928, E. P. Van Duzee (C.A.S.).

Most closely related to *tumidifrons*, but somewhat larger than that species. The preocular part of the head is relatively longer, lateral margins more flaring anteriorly; antenniferous tubercles scarcely visible from above; process at the anterior angle of pronotum longer and the lateral margins more shallowly sinuate opposite the median transverse impression.

Weda grossa, n. sp.

Fig. 6

Length 6.40 mm. Black, shining; antennae, rostrum and tarsi testaceous. Head wider across eyes than long; eyes strongly stylated; lateral margins strongly sinuate before eyes thence grad-



Figs. 18–36.—18, *Oncozygia clavicornis* Stål (Myrtle Beach, S. C.), aedeagus; 19, *Weda parvula* (Van Duzee) (Fort Collins, Colo.), aedeagus; 20, *Amaurochrous dubius* (P. de B.) (Lake Placid, Fla.), aedeagus, 21, *Oncozygia clavicornis* Stål (Myrtle Beach, S. C.), right clasper; 22, same, posterior view of hypopygium; 23, same, dorsal view of right hypopygial appendage; 24, *Weda parvula* (Van Duzee) (Fort Collins, Colo.), right clasper; 25, same, posterior view of hypopygium; 26, same, dorsal view of right hypopygial appendage; 27, *W. stylata*, n. sp. (paratype, Salton, Calif.), right clasper; 28, same, posterior view of hypopygium; 29, same, dorsal view of right hypopygial appendage; 30, *W. tumidifrons*, n. sp., right clasper; 31, same, posterior view of hypopygium; 32, same, dorsal view of hypopygial appendage, 33, *Podops inunctus* (F.) (Toulouse, France), aedeagus; 34, same, right clasper; 35, same, posterior view of hypopygium; 36, same, dorsal view of hypopygial appendage. (All homologous parts drawn to the same scale.)

ually expanding to the broadly rounded apices of juga, each appearing somewhat spatulate anteriorly; juga coarsely and closely punctate; antenniferous tubercles short, entirely visible from above; bucculae strongly expanded posteriorly, lower margins broadly rounded. Antennae with the first and third segments subequal, second about one-fourth shorter than first and subequal to fourth, terminal segment as long as the two preceding segments united. Rostrum short, reaching only to anterior coxae. Pronotum twice as wide as long; subacute process at each anterior angle short, not extended outwardly as far as outer margin of the eye; prehumeral processes subacute, well projected beyond the rounded humeral margins; lateral margin before each process lightly expanded and narrowly reflexed, the lateral sinus rather shallow; disk before the median transverse impression coarsely punctate. Outline of head and pronotum as shown by figure 6. Scutellum nearly one-third longer than wide, rather coarsely and evenly punctate, especially towards base.

Holotype: Female, Mazatlán, Sinaloa, *Mexico*; U.S.N.M. type no. 61519.

Much larger and appearing more polished than any other known species of the genus. Head more strongly sinuate before the eyes than in *parvula*; antenniferous tubercles short, more obtuse; anterolateral process shorter and blunter.

Genus **Amaurochrous** Stål

Podops, subgenus *Amaurochrous* Stål, 1872, Enum. Hemip. **2:** 15.

Amaurochrous Schouteden, 1905, Gen. Insectorum, fasc. 30: 32; Kirkaldy, 1909, Cat. Hemip. Heterop. **1,** Cimicidae: 237; Zimmer, 1912, Contr. Dept. Ent. Univ. Nebraska, no. 4: 20; 1912, Univ. Nebraska Studies **11:** 238; Van Duzee, 1917, Cat. Hemip. N. Amer.: 26 (subgen.); Hart, 1919, Bull. Illinois Nat. Hist. Surv. **13** (7): 171; Barber and Bruner, 1932, Journ. Dept. Agr. Puerto Rico **16:** 246.

Scotinophara Stål, 1867, Öfv. Vet.-Akad. Förh. **24:** 523.

Podops Uhler, 1878, Proc. Boston Soc. Nat. Hist. **19:** 368; 1886, Check List Hemip. Heterop.: 5; Lethierry and Severin, 1893, Cat. Gen. Hemip; **1:** 55; Van Duzee, 1904, Trans. Amer. Ent. Soc. **30:** 21, 22; Bergroth, 1908, Mem. Soc. Ent. Belg. **15:** 146; Banks, 1910, Cat. Nearctic Hemip. Heterop.: 92; Parshley, 1915, Psyche **12:** 171; Parshley, 1923, *in* Hemip. Connecticut: 755; Blatchley, 1926, Heterop. East. N. Amer.: 54; Torre-Bueno, 1939, Ent. Amer. **19:** 197; 1940, Bull. Brooklyn Ent. Soc. **35:** 51.

Fuscocinereous. Head shorter than pronotum. Antennae each 5-segmented, with a tendency for fusion of the second and third segments. Anterolateral angle of the pronotum produced in a short subacute tooth or an elongate hornlike process which in some species extends well beyond outer margin of the eye; prehumeral process subacute to obtusely rounded at apex; lateral margin of pronotum concavely sinuate (except *brevitylus* and *vanduzeei*); well-developed tubercles in the cicatrices. Hypopygeal appendages widely separated, not overlapping the deep, concave, median sinus on the hind margin of the hypopygial cup.

Type: *Amaurochrous dubius* (Palisot de Beauvois) (designated by Schouteden in 1905).

As indicated in the bibliography above, there has been considerable disagreement among past authors as to the position of *Amaurochrous*. Some recent writers have gone so far as to treat the name as a synonym of *Podops* Laporte, 1832. Superficially the species belonging to these genera do show a close similarity; however, closer scrutiny quickly reveals important differences. The shape of the process at each anterolateral angle is noticeably different. In *Podops* it is flattened and spatulate, in *Amaurochrous* it is conical or tuberculate (comp. Figs. 9 and 10). Striking differences are apparent in the male genitalia. With minor variations the claspers of all species of *Amaurochrous* conform to the pattern exhibited by the genotype *dubius* (Fig. 49) which is quite different from *Podops inunctus* (Fabricius) (Fig. 34). The bilobed dorsal vesicula of the aedeagus (Fig. 33) and very much enlarged hypopygeal appendages (Fig. 36) of *P. inunctus* are also unlike the homologous structures of *A. dubius* and its related species.

KEY TO SPECIES OF AMAUROCHROUS

1. Tylus and juga equal or very nearly so.......2
   Juga evidently longer than tylus and often contiguous before it.......................4
2. Rostrum long, extended past metasternal coxae; anterolateral tooth of pronotum produced in an elongate, hornlike process extended obliquely well beyond outer margin of eye........................*magnus*, n. sp.
   Rostrum shorter, scarcely extended beyond mesosternal coxae; anterolateral tooth of pronotum, short, acute or subacute, at most extended but little beyond outer margin of eye.....................................3
3. Anterolateral tooth of pronotum, acute, smaller, not projected beyond outer margin of eye; prehumeral process narrowly rounded

to subacute, extended but little, if at all, beyond humeral margin (Fig. 12)
cinctipes (Say)

Anterolateral tooth of pronotum stout, extended a little beyond outer margin of eye; prehumeral process forming a broadly rounded lobe projecting well beyond humeral margin (Fig. 10)
dubius (Palisot de Beauvois)

4. Lateral margin of pronotum distinctly concavely sinuate in the middle (Fig. 15)
ovalis, n. sp.

Lateral margin of pronotum fairly straight, scarcely concavely sinuate (Figs. 13 and 16). 5

5. Anterolateral tooth of pronotum scarcely extended as far as outer margin of eye; antennae shorter, but little longer than pronotum; ocelli less widely separated (Eastern and Middle West) (*parvulus* of most authors)
brevitylus, n. sp.

Anterolateral tooth extended a little beyond outer margin of eye; antennae much longer than pronotum; ocelli more widely separated (California) .... *vanduzeei*, n. sp.

Amaurochrous dubius (Palisot de Beauvois)

Figs. 1, 10, 11, 20, 49, 50, 51

Scutellera dubia Palisot de Beauvois, 1805, Ins. Afr. Amer.: 33, pl. 5, fig. 6 (reproduced on our Fig. 1).

Podops (*Amaurochrous*) *dubius*, Stål, 1872, Enum. Hemip. **2:** 15; Van Duzee, 1917, Cat. Hemip. N. Amer.: 26 (part).

Amaurochrous dubius, Schouteden, 1905, Gen. Insectorum, fasc. 30: 33; Kirkaldy, 1909, Cat. Hemip. Heterop. **1,** Cimicidae: 237; Bruner and Barber, 1949, Mem. Soc. Cubana Hist. Nat. **19:** 156.

Podops peninsularis Blatchley, 1924, Ent. News **35:** 87; 1926, Heterop. East. N. Amer.: 55, 56; Torre-Bueno, 1939, Ent. Amer. **19:** 198. NEW SYNONYMY.

This has the same general appearance and size as *cinctipes* but differs in the following respects: The anterolateral tooth of the pronotum is stouter and extended somewhat beyond the outer margin of the eye; the prehumeral process is broadly rounded or lobate and extended well beyond the humeral margin, and preceded by a more strongly concave sinus (compare outlines of the heads and pronota as shown in Figs. 10 and 12).

Palisot de Beauvois described *dubius* from San Domingo; Stål reported the species from Cuba. Specimens have been examined from Cuba, Florida, and Louisiana. In addition, the U. S. National Museum collection contains a number of specimens from Mexico and Central America intercepted in cargoes of bananas.

Blatchley, 1926, described *peninsularis* from Florida. A paratype in the collection of the U. S. National Museum agrees with what we have determined as *dubius* from Cuba and Florida. In our opinion Blatchley was in error both in his description (pp. 55–56) and in his identification (Fig. 11) of Palisot de Beauvois' species; in consequence he redescribed the true *dubius* as *peninsularis*. A photographic reproduction of Palisot de Beauvois's illustration of *dubius* is shown on Fig. 1.

There is some reason to question the status of *cinctipes* as a species distinct from *dubius*. Certain specimens of *dubius* from Mexico and several specimens from Texas which we identify as *cinctipes* tend to intergrade. It may be that additional material collected along the zone where *dubius* overlaps with *cinctipes* will show *cinctipes* to be a subspecies of *dubius*. This opinion is further supported by the slight degree of difference exhibited by the claspers and hypopygial appendages of the two species (compare Figs. 49, 50 and 40, 42).

Amaurochrous cinctipes (Say)

Figs. 12, 40, 41, 42

Tetyra cinctipes Say, 1828, Amer. Ent. **3:** 94, pl. 43; LeConte, 1859, Compl. Writ. Say **1:** 94, pl. 43, fig. 4.

Scotinophara cinctipes, Stål, 1867, Öfv. Vet.-Akad. Förh. **24:** 502.

Podops (*Amaurochrous*) *cinctipes*, Stål, 1872, Enum. Hemip. **2:** 15; Van Duzee, 1917, Cat. Hemip. N. Amer.: 26; Leonard, 1928, List Insects New York: 78.

Amaurochrous cinctipes, Olsen, 1912, Journ. New York Ent. Soc. **20:** 49.

Podops cinctipes, Uhler, 1886, Check List Hemip. Heterop.: 5; Lethierry and Severin, 1893, Cat. Gen. Hemip. **1:** 56; Van Duzee, 1894, Bull. Buffalo Soc. Nat. Sci. **5:** 170; 1904, Trans. Amer. Ent. Soc. **30:** 22; Torre-Bueno, 1907, Ent. News **18:** 441; 1908, Journ. New York Ent. Soc. **16:** 226; Banks, 1910, Cat. Nearctic Hemip. Heterop. 92; Zimmer, 1912, Univ. Nebraska Studies **11:** 238; 1912, Contr. Dept. Ent. Univ. Nebraska no. 4: 20; Stoner, 1915, Ent. News **27:** 355; Parshley, 1915, Psyche **22:** 171; 1917, Occ. Pap. Boston Soc. Nat. Hist. **7:** 6; Stoner, 1917, Bull. Lab. Nat. Hist. Univ. Iowa **7:** 6; Parshley, 1923, Can. Ent. **45:** 69–70, figs. 1, 2 (ecology); 1923, *in* Hemip. Connecticut: 755; Blatchley, 1926, Heterop. East. N. Amer.: 55; Brimley, 1938, Insects North Carolina: 61; Torre-Bueno, 1939, Ent. Amer. **19:** 198.

Podops peninsularis, Torre-Bueno (not Blatchley), 1939, Bull. Brooklyn Ent. Soc. **34:** 214.

Length 5–7.5 mm. Head across eyes much wider than long; preocular portion, viewed dorsally, subequal to remainder; tylus and juga equally long; antennae nearly one-fourth longer than head; first four segments nearly equal, fifth but little longer than the preceding two segments combined. Pronotum across humeri over twice as wide as long, a little longer than head; lateral margin very narrowly impressed and reflexed; anterolateral tooth acute, extended outward almost to outer margin of eye; prehumeral process subacute to narrowly obtusely rounded at apex, extended but little beyond humeral margin, lateral margin before this rather strongly concavely sinuate. Outline of the head and pronotum as shown by Fig. 12. Scutellum over twice as long as pronotum, one-fourth longer than head and pronotum combined.

Distribution: Eastern North America from Quebec and the New England States south to the Carolinas and west to Minnesota, Nebraska, Kansas, Missouri, and extending south into Louisiana and Texas.

Two specimens in the collection of the U. S. National Museum, which bear the label "along Black R., 3 mi. so. of Carlsbad Cave, N. Mex.," apparently belong here although the genital structures are not exactly typical of the species.

Hypopygium, hypopygial appendages, and clasper as in Figs. 41, 42, 40.

As noted in the discussion under *A. dubius*, there is some reason to believe that *cinctipes* is actually no more than a subspecies of *dubius*. Certainly the differences distinguishing these two species are not of the same order as those which distinguish them from the other species of the genus.

Amaurochrous brevitylus, n. sp.

Figs. 16, 37, 38, 39

Podops parvulus Van Duzee, 1904, Trans. Amer. Ent. Soc. **30:** 22 (part); Bergroth, 1908, Mem. Soc. Ent. Belg. **15:** 146; Banks, 1910, Cat. Nearc. Hemip. Heterop.: 93; Zimmer, 1912, Contr. Dept. Ent. Univ. Nebraska no. 4: 20; Stoner, 1917, Bull. Lab. Nat. Hist. Univ. Iowa **7:** 6; Parshley, 1923, *in* Hemip. Connecticut: 755; Blatchley, 1926, Heterop. East. N. Amer.: 55–57; Torre-Bueno, 1939, Ent. Amer. **19:** 198.

Amaurochrous parvulus, Schouteden (not Van Duzee), 1906, Gen. Insectorum, fasc. 30: 33, pl. 2, fig. 13; Hart, 1919, Bull. Illinois Nat. Hist. Surv. **13** (7): 171.

Amaurochrous dubius, Olsen (not Palisot de Beauvois), 1912, Journ. New York Ent. Soc. **20:** 50.

Length 5.30–5.80 mm. Head distinctly wider, across eyes, than long; preocular part distinctly longer than remainder; juga distinctly longer than tylus, usually not contiguous anteriorly; lateral margin slightly concave before stylated eyes. Antenna with basal segment a little longer than second, the latter subequal to the third and fourth, fifth very nearly equal to the preceding three segments combined. Pronotum about twice as wide as long; lateral margin very nearly straight, anterolateral tooth of pronotum acute, scarcely extended beyond outer margin of eye; prehumeral process forming an obtuse tooth. Outline of head and pronotum as shown in Fig. 16. Scutellum about one-third longer than wide, over twice as long as head and pronotum combined.

Hypopygium, hypopygial appendage, and clasper as in Figs. 38, 39, 37.

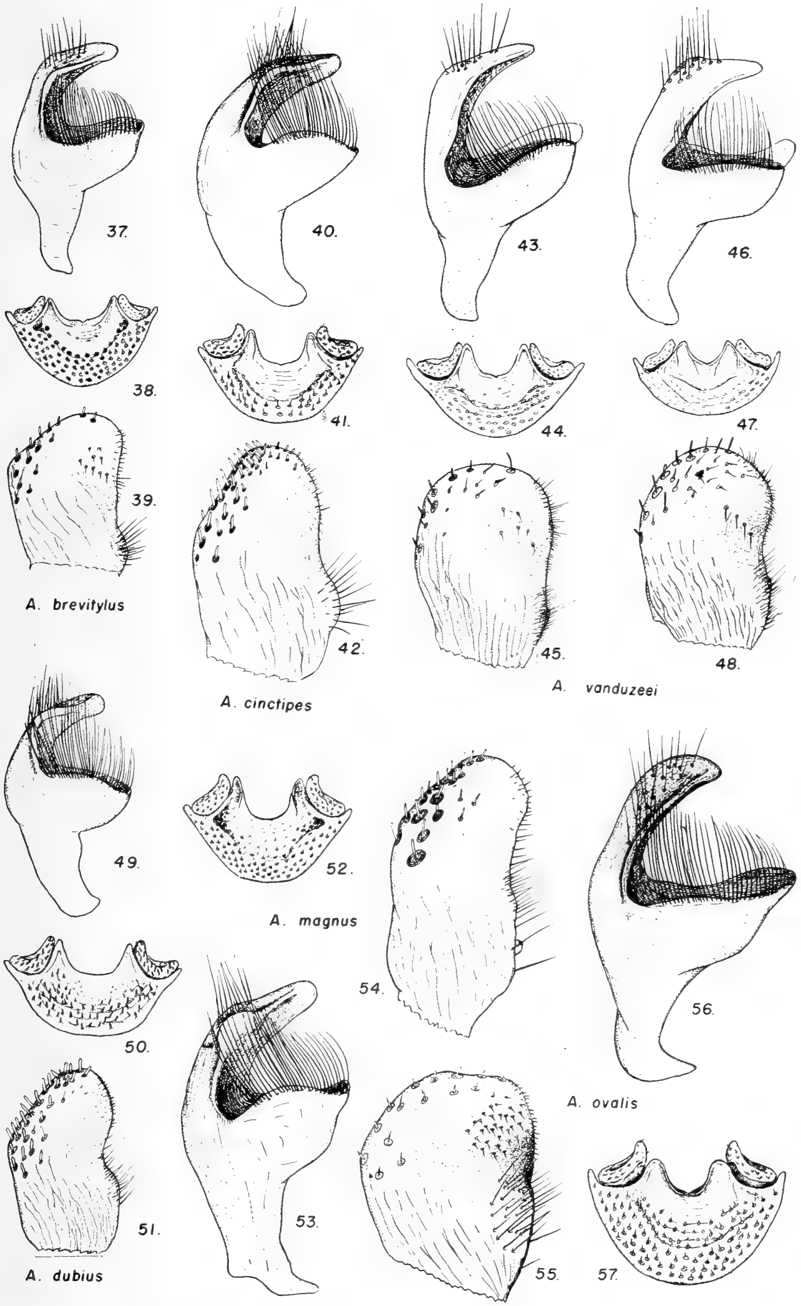
Type: Male, *Massachusetts*: Waterton, June 28, 1920, C. C. Sperry, U.S.N.M. type no. 61520. Paratypes, males and females: 1, Andover, ex P. R. Uhler collection. *New York*: 1, Northwest, L. I., June 14, 1949, Roy Latham; 1, Orient, L. I., May 28, 1932, Roy Latham. *New Jersey*: 1, Paterson, May 3, 1903, H. G. Barber. *Wisconsin*: 1, Madison, June 1, 1949, student collection. *Minnesota*: 1, Park Rapids, July 24, 1935, P. W. Oman. *Iowa*: 2, Lake Okoboji, June 25, 1916; 4, July 1916, L. Buchanan; 1, July 8, 1916, O. Stoner; Ames, July 5, 1932, H. M. Harris; 1, Solon, May 17, 1915, L. Buchanan; 1, Esterville, June 5, 1916, L. Buchanan. *Nebraska*: 1, Sand Hills, July, H. G. Barber. *Kansas*: 3, Topeka, May 30, Popenoe; 1, "Kan."; 2, Douglas County, 900 feet, F. H. Snow; 1, October 9, 1946. *Arizona*: Mount Lemon, April 29, 1948, R. H. Beamer.

Fourteen of the paratypes listed above are in the U. S. National Museum collection; four are in the Snow Insect Collection of the University of Kansas; one, in the University of Wisconsin Collection; and one is in the private collection of H. M. Harris.

Amaurochrous vanduzeei, n. sp.

Figs. 13, 14, 43–48

Length 6–7 mm. Head across eyes nearly one-third wider than long; juga longer than tylus, and often contiguous before it. Antenna with second segment shorter than the basal, third a little longer than fourth and the fifth equal to third and fourth combined. Pronotum twice as wide as long; anterolateral tooth acute, extending directly outward a little beyond outer margin of eye; lateral margin very nearly straight; pre-



FIGS. 37–54.—37, *Amaurochrous brevitylus*, n. sp. (paratype, Sand Hills, Nebr.), right clasper; 38, same, posterior view of hypopygium; 39, same, dorsal view of hypopygial appendage; 40, *A. cinctipes* (Say) (Staten Island, N. Y.), right clasper; 41, same, posterior view of hypopygium; 42, same, dorsal view of hypopygial appendage, 43, *A. vanduzeei*, n. sp. (paratype, Bay Farm Island, Alameda County, Calif.), right clasper; 44, same, posterior view of hypopygium; 45, same, dorsal view of hypopygial appendage; 46, *A. vanduzeei*, n. sp. (paratype, Los Angeles, Calif.), right clasper; 47, same, posterior view of hypopygium; 48, same, dorsal view of hypopygial appendage; 49, *A. dubius* (P. de B.) (Lake Placid. Fla.), right clasper; 50, same, posterior view of hypopygium; 51, same, dorsal view of hypopygial appendage; 52, *A. magnus*, n. sp. (paratype, Florida, ex Uhler coll.); 52, same, posterior view of hypopygium; 53, same, right clasper; 54, same, dorsal view of hypopygial appendage; 55, *A. ovalis*, n. sp. (holotype); 55, same, dorsal view of hypopygial appendage; 56, same, right clasper; 57, same, posterior view of hypopygium.

humeral process narrowly rounded, extending but little beyond humeral margin. Outline of head and pronotum as shown by figure 13. Scutellum about one-third longer than wide.

Hypopygium, hypopygial appendage and clasper as in figures 44, 45, and 43.

Type: Male, Bay Farm Island, Alameda County, *California*, February, 25, 1939, K. S. Hagen (C.A.S.). Paratypes: 12 males and 18 females with the same data as type; male and 2 females, same locality, November 11, 1938, W. F. Barr; male and female, Millbrae, Calif., August 25, 1918, E. P. Van Duzee (C.A.S.). Five male and 5 female paratypes agreeing with the type are retained for the U.S.N.M. collection; male, Los Angeles, Calif., Coquillett (U.S.N.M.).

This species is most closely related to *brevitylus*, new species, but averages larger than that species; the antennae are longer in relation to the length of the pronotum. In addition there are constant differences in the genital structures. The male from Los Angeles County differs in certain respects from the form represented by the type. The most noticeable difference is in the shape of the head. (Compare Figs. 13 and 14.) Close similarity of the genital structure is accepted as evidence that only one species is involved. (See Figs. 43–48.)

Amaurochrous ovalis, n. sp.

Figs. 15, 55, 56, 57

Length 7–8.00 mm. Head about one-third wider across than long; juga, coarsely, closely punctate, much longer than tylus but scarcely contiguous before it, bluntly rounded at apices. Antenna with the basal and second segments subequal, third a little longer than second and subequal to fourth, terminal segment somewhat shorter than third and fourth combined. Pronotum very nearly twice as wide across humeri as long, but little longer than head; anterolateral tooth rather stout, subacute, extending directly outward a little beyond outer margin of eyes; prehumeral process subacute, well extended beyond humeral margin; lateral margin narrowly pressed, marginal sinus rather shallow. Outline of head and pronotum as shown in Fig. 15. Scutellum about one-third longer than wide, not quite reaching apex of abdomen.

Hypopygium, hypopygial appendage, and clasper as in figs. 57, 55, 56.

This is a larger species than *cinctipes* with the body appearing somewhat oval in outline.

Type: Male, Clemson College, *South Carolina*, June 26, 1932, O. L. Cartwright, U.S.N.M. type no. 61521. Paratypes: 2 females, Mrytle Beach, S. C., April 23, 1919, E. R. Kalmbach (U.S.N.M.) Benson, *North Carolina*, August 9, 1934, R. H. Beamer (U.K.S.M.); Myrtle Beach, S.C., April 22, 1919, Patuxent Fish and Wildlife Refuge Laboratory, through R. T. Mitchell.

Amaurochrous magnus, n. sp.

Figs. 17, 52, 53, 54

Podops dubius, Van Duzee (not Palisot de Beauvois), 1904, Trans. Amer. Ent. Soc. **30:** 77; Blatchley, 1926, Heterop. East. N. Amer.: 55–56, fig. 11.

Amaurochrous dubius, Barber (not Palisot de Beauvois), 1914, Bull. Amer. Mus. Nat. Hist. **33:** 521; Hart, 1919, Bull. Illinois Nat. Hist. Surv. **13** (7): 172; Barber and Bruner, 1932, Journ. Dept. Agr. Puerto Rico **16:** 246.

Length 7.70–8.00 mm. This is a much larger species than *cinctipes* and easily distinguished from all other species of the genus by the much longer, hornlike, anterolateral tooth of the pronotum which is extended well beyond outer margin of eye; the enlarged bluntly rounded prehumeral process which projects well beyond humeral margin and especially by the much longer rostrum which extends beyond the metasternal coxae. Outline of head and pronotum as shown in figure 17.

Hypopygium, hypopygial appendage and clasper as in Figs. 52, 54, 53.

Type: Male, Edgewater, *Florida*, February 28, 1939, C. A. Frost, U.S.N.M. type no. 61522. Paratypes, males and females: Edgewater, Fla., same data as type; Haulover, Fla., March, Hubbard and Schwarz; Paradise Key, Fla., February 23, 1919, H. S. Barber; Georgia, 8 specimens, no data, colln. P. R. Uhler, U.S.N.M.; Lake Placid, Fla., July 13, 1948, R. H. Beamer (U.K.S.M.); Gueydan, *Louisiana*, June 26, 1925, at light, E. Kalmbach, Patuxent Fish and Wildlife Refuge Laboratory, through R. T. Mitchell.

This is the species which has been misidentified as *dubius* by several authors, but comparison with Palisot de Beauvois's figure 6 on plate 5 indicates very clearly that this is an error. (See Fig. 1.)

Van Duzee (1904, Trans. Amer. Ent. Soc. **30:** 77) reports a pair taken at Fortress Monroe, Va. As these specimens are no longer in the collection of the U. S. National Museum, it is impossible to confirm this record.

ZOOLOGY.—*A new crawfish of the genus* Procambarus *from Louisiana and Arkansas (Decapoda: Astacidae).*

GEORGE HENRY PENN, Tulane University of Louisiana, New Orleans. (Communicated by Fenner A. Chace, Jr.)

The new species described here has been known to me for more than 10 years; however, all the specimens in collections were immature, and my efforts to obtain mature forms proved fruitless. Recently Maj. Thomas H. Nickerson, U.S.A.F., at Louisiana Polytechnic Institute, Ruston, La., succeeded in collecting a small series of mature specimens in north-central Louisiana; these include the holotype and allotype and the majority of the paratypes. Major Nickerson has kindly lent me his entire collection as well as his field notes.

I have named this species in honor of Paul Tulane (1801–1887), who in 1884 gave a substantial part of his fortune to the University of Louisiana, founded half a century before, thus enabling it to greatly expand facilities. The administrators of this fund subsequently added the name of Tulane to the existing title of the University.

Procambarus tulanei, n. sp.

Figs. 1–12

Holotype male, form I.—Body ovate; abdomen slightly shorter than length of cephalothorax (53.0–51.0). Height of cephalothorax (Figs. 1, 2) equal to width in region of caudodorsal margin of cervical groove.

Areola wide, with three punctations in narrowest part; length about 7.3 times greater than width at narrowest part (18.0–2.3). Cephalic portion of cephalothorax about twice as long as the areola; length of areola about 34 percent of entire length of cephalothorax.

Rostrum spatulate, relatively short and wide; sides converging anteriorly to the base of the acumen; without lateral spines or shoulders; acumen short. Margins of rostrum raised, keeled, and not swollen; upper surface smoothly excavate.

Postorbital ridges well-developed, terminating anteriorly in rounded shoulders. Branchiostegal spine obsolete. Without lateral spines on sides of cephalothorax; upper surface of cephalothorax sparsely punctate; lateral portions finely granulate.

Cephalic section of telson with two spines in each caudolateral corner, the lateral one about three times the length of the median one.

Length of epistome (Fig. 3) about two-thirds of width; margins raised and slightly swollen; with a small anterior projection.

Antennae reaching to end of abdomen. Antennal scale wide (Fig. 4), greatest width distad of middle; lateral margin terminating distally in a sharp spine; total length a little less than half the length of the areola (8.3–18.0). Entire median margin fringed with hair.

Exposed (caudal) surface of third maxillipeds heavily clothed with hair.

Right chela (Fig. 5) long and narrow; palm thin, but somewhat inflated, fingers normal; palm and bases of fingers tuberculate; inner margin of palm heavily bearded. Both fingers terminating in short corneous tips, that of dactyl overhanging the other when the fingers are closed. Dactyl with about thirteen rounded tubercles proximally, the second and sixth from base largest and approximately equal to each other; opposable margin of immovable finger with eleven rounded tubercles at base, the fifth being the largest. Carpus (Fig. 5) tuberculate along inner margin; a single large spine at distal end beneath.

Hooks (Fig. 6) present on ischiopodites of third pereiopods only; length of hook equal to about two-thirds of the diameter of the ischiopodite.

First pleopods (Figs. 7–9) reaching to cephalic side of coxopodite of third pereiopods when abdomen is flexed. Apex terminating in four parts. Mesial process elongate, somewhat flattened on its transverse axis, extending slightly laterocaudad and distad beyond apices of other processes. Cephalic process subacute, a little less than half the length of the mesial process, extending slightly cephalomesad; a distinct angular hump present on cephalic margin at base of cephalic process. Caudal element consisting of a straight, elongate caudal knob capped distally by the corneous caudal process which is irregularly leaflike and excavate on its caudal face. Central projection corneous, saber-shaped and extending slightly caudomesad; fusion line of its two elements distinct.

Morphotype male, form II.—Similar to the holotype in general appearance. First pair of pleopods (Figs. 10, 11) reaching to cephalic side of coxopodite of third pereiopods when abdomen is flexed; terminal processes non-corneous and reduced.

Allotype female.—Similar to holotype in general appearance. Annulus ventralis (Fig. 12) rounded; an anteroposterior trough-like depression extends from cephalic margin caudad to a centrally located pitlike depression; the sinus originates in this central pit and then runs posterosinistrad a short distance before making a sharp turn posterodextrad approximately to the midline where it turns posterosinistrad and extends nearly to the caudal margin. Cephalic half on either side of median trough raised and with a series of prominent irregular mammillary processes along border of trough.

Measurements.—As follows, in millimeters:

	Holotype	*Allotype*	*Morphotype*
Cephalothorax:			
Length	53.0	55.5	53.0
Width	26.0	29.0	27.5
Height	26.0	26.0	26.5
Areola:			
Length	18.0	19.0	18.0
Width (at narrowest part)	2.3	2.3	2.0
Rostrum:			
Length	12.0	12.0	12.0
Width at base	8.2	9.2	8.5
Abdomen:			
Length	51.0	54.5	52.5
Right chela:			
Length of outer margin of hand	49.0	40.0	48.0
Length of dactyl	30.0	25.0	30.0
Length of inner margin of palm	18.5	15.0	18.0
Width of palm	16.5	15.5	16.0

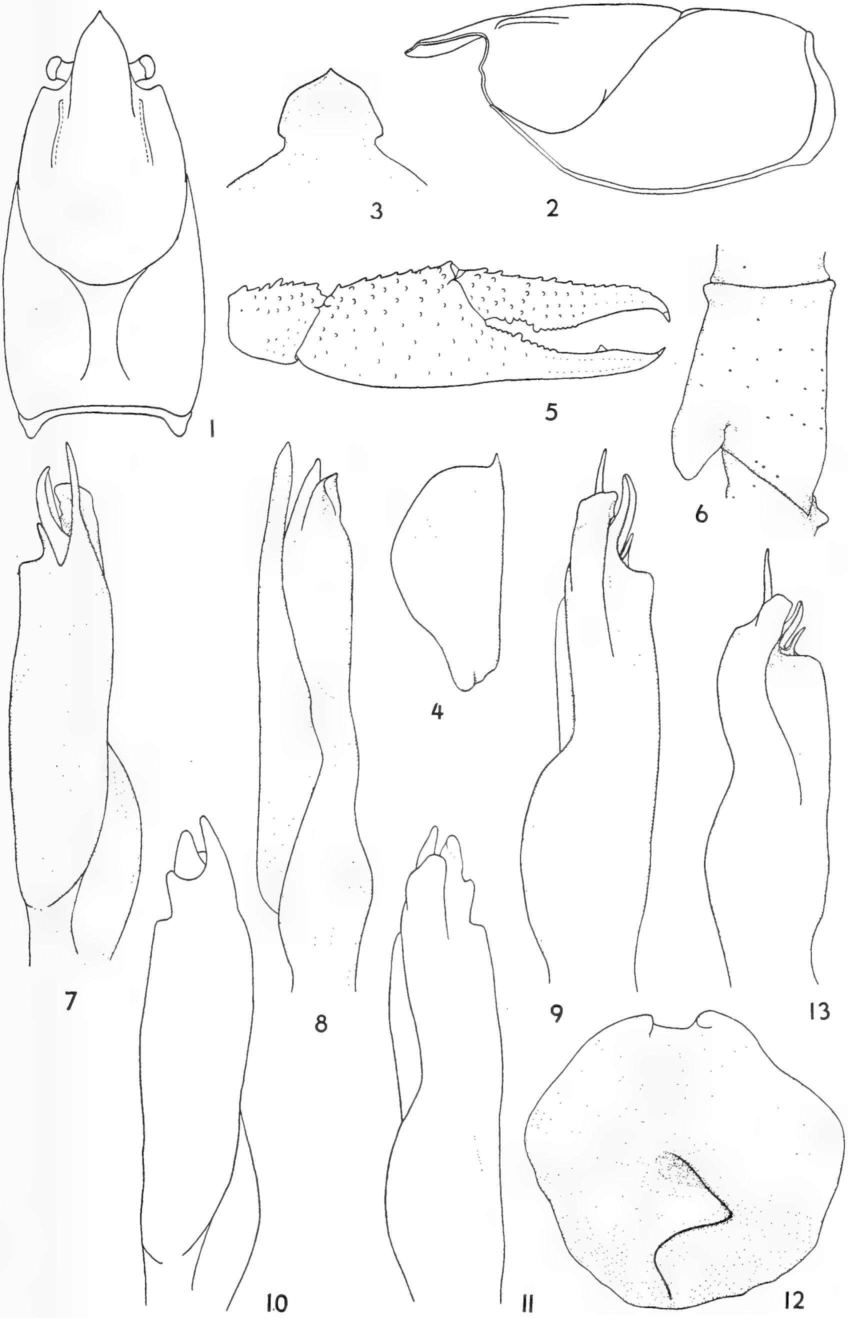
Type locality.—The holotype and allotype were collected from a small unnamed tributary of Bayou D'Arbonne, 4 miles west of Dubach (on Louisiana Highway 288), Lincoln Parish, La., on February 29, 1952, by Maj. Thomas H. Nickerson, U.S.A.F. Bayou D'Arbonne is a tributary of the Ouachita River, which combines with several other small rivers before emptying into the Red River. At the collecting site the creek is a narrow (3 feet wide), shallow, flowing stream; the holotype and allotype were dug from the same burrow, which extended about 2 feet straight into the blue-clay stream bank at a 45° angle before forking into two equal compartments, one crawfish in each terminus. No other species were collected at this locality.

The morphotype was collected from Big Creek at Fishville (3 miles east of Pollock on Louisiana Highway 19), Grant Parish, La., on February 22, 1938, by Percy Viosca, Jr. Big Creek is a tributary of Little River, which joins the same assemblage of streams into which the Ouachita River drains. At the collecting site Big Creek is a large, shallow stream with a sand bottom, sparse aquatic vegetation, and shaded banks. Other crawfishes collected at the same time were *Procambarus vioscai* Penn, *Procambarus blandingii acutus* (Girard), and *Orconectes palmeri creolanus* (Creaser).

Disposition of types.—The holotype, allotype, and morphotype are deposited in the United States National Museum, nos. 93655, 93656, and 79928, respectively. Of the paratypes series, one form II male, a female, and a juvenile female are in the National Museum; one form I male is in the collection of Dr. Horton H. Hobbs, Jr., at the University of Virginia; one form I male, one female, five juvenile males, and two juvenile females are in the Tulane University collection; and one form I male, two form II males, four females, and three juvenile males have been retained in his personal collection by Major Nickerson at Louisiana Polytechnic Institute.

Specimens examined.—Twenty-three paratypes of *Procambarus tulanei* in addition to the three types have been examined from Louisiana and Arkansas. These records and a summary of their deposition are as follows: LOUISIANA: Caldwell: Tributary of Ouachita River, 4.5 miles east of Columbia, August 2, 1948, L. L. Ellis (TU 430); Grant: Big Creek at Fishville, February 22, 1938, P. Viosca, Jr. (U.S.N.M. no. 79928); Jackson: Tributary of Dugdemona Bayou, 2 miles south of Clay, May 15, 1952, T. H. Nickerson (THN); Lincoln: Tributary of Bayou D'Arbonne, 0.25 miles north of Ruston, February 14, 1952, T. H. Nickerson (TU 2645); tributary of Bayou D'Arbonne, 4 miles west of Dubach, February 29, 1952, T. H. Nickerson (U.S.N.M, THN, TU 2648, 2831); Pugh's Pond, Ruston, April 1, 1952, T. H. Nickerson (THN); burrows in bank of tributary of Bayou D'Arbonne, Ruston, May 12, 1952, T. H. Nickerson (THN); burrows on L.P.I. campus, Ruston, May 18, 1952, T. H. Nickerson (THN). ARKANSAS: Columbia: [Tributary of Bayou Dorcheat], 7.8 miles south of Magnolia, April 9, 1952, E. A. Lachner et al. (U.S.N.M.).

Relationships.—In 1905 Ortmann placed *Procambarus simulans* in the *Digueti* section along



Figs. 1–12.—*Procambarus tulanei*, n. sp.: 1, 2, Cephalothorax of holotype; 3, epistome of holotype; 4, antennal scale of holotype; 5, chela and carpus of holotype; 6, hook of holotype; 7–9, mesial, caudal, and lateral views of first pleopod of holotype; 10, 11, mesial and lateral views of first pleopod of morphotype; 12, annulus ventralis of allotype.

Fig. 13.—*Procambarus simulans* (Faxon): Lateral view of first pleopod of form I male from an impounded lake, 13 miles south of Channing, Oldham County Tex., July 1, 1952, F. R. Cagle et al. (TU 2795).

Pubescence removed from all structures illustrated.

with a heterogenous assemblage of species, and *P. gracilis* and *P. hagenianus* in the *Gracilis* section. Hobbs (1942) revised this classification and placed the three species mentioned above in a separate group (the *Simulans* group) of his newly established *Barbatus* Section. *Procambarus tulanei* clearly belongs to the *Simulans* group and is most closely related to *P. simulans*. *P. tulanei* and *P. simulans* closely resemble each other in most superficial characteristics. The two species can be separated easily by the structure of the first pleopod of the male (*cf.* Figs. 9 and 13), but not by the annuli ventrali of the females which are quite variable in both species. The geographic ranges of these two species meet in western Louisiana but apparently do not overlap.

LITERATURE CITED

HOBBS, HORTON H., Jr. *The crayfishes of Florida.* Univ. Florida Publ., Biol. Sci. Ser., **3** (2): 1–179. 1942.

ORTMANN, A. E. *The mutual affinities of the species of the genus* Cambarus, *and their dispersal over the United States.* Proc. Amer. Philos. Soc. **44**: 91–136. 1905.

HELMINTHOLOGY.—*Studies on the helminth fauna of Alaska: XII, The experimental infection of Alaskan gulls* (Larus glaucescens *Naumann*) *with* Diphyllobothrium *sp.*

BERT B. BABERO, Arctic Health Research Center, U. S. Public Health Service, Anchorage, Alaska. (Communicated by Robert Rausch.)

For over a period of three years cestodes belonging to the genus *Diphyllobothrium* Cobbold (1858) have been routinely recovered from various Alaskan mammals, including man. The epidemiological nature of this helminthic infection is not yet completely understood. Experimental as well as field research has been undertaken by the Animal-borne Disease Branch of the Arctic Health Research Center relative to the possible control of diphyllobothriasis in Alaska. The results of the work to date, including the laboratory infection of dogs (*Canis familiaris*), foxes (*Vulpes fulva* and *Alopex lagopus*), bears (*Ursus americanus*), gulls (*Larus glaucescens*), and man, present strong evidence that only one species is involved. However, since its life cycle has not been experimentally determined, and since morphological study does not allow speciation of the adult worm, this must remain only an assumption. The present paper on the infection of gulls with *Diphyllobothrium* sp. constitutes a preliminary report.

The writer wishes to express his gratitude to Dr. Robert Rausch, chief of the Animal-borne Disease Branch, under whose supervision this work was carried out and who identified the cestode material, and to Miss Reggie Sacressen, whose aid in connection with this project contributed greatly to its success.

MATERIAL AND METHODS

For these experimental infections young gulls (*Larus glaucescens*) were secured from isolated nesting grounds on islands in Cook Inlet, about 20 miles southwest of the city of Anchorage. The numerous small island nesting sites were heavily grown to sedges and thus afforded ample protection for the young of hundreds of birds, among which several species were represented.

Thirty-six birds taken on June 21, 1951, were downy young; these were collected directly from their nests, or in the immediate vicinity. The nests were numerous and widely scattered and, in several instances, still contained unhatched eggs. The estimated ages of the birds taken ranged from 1 day to 2 weeks, and their weights were from 55 to 340 grams.

On July 15, 15 juvenile birds were collected from these same nesting grounds. The young gulls were located by flushing them from their grassy niches and by cutting off their retreat as they swam to shore. At this time it was noted that a few nests still contained eggs; examination of several of these revealed that they contained dead embryos. The young gulls taken were apparently from 1 to 6 weeks old and weighed 207 to 1,034 grams.

As a control 22 of the first group of 36 birds taken on June 21, and all those collected July 15, were examined post mortem, at the time of collection, to determine the extent of natural helminth infections. No parasites were recovered from the downy-young birds, and only one species of a strigeid trematode was taken from the juveniles.

The 14 gulls intended for experimental use, after having been observed for about two weeks and having become accustomed to captivity, were color-banded, divided into five groups (see Table 1), and placed in five separate cages—designated A, B, C, D, and E.

During the course of the experiment, king salmon (*Oncorhynchus tshawytscha*), which had been quick-frozen and kept for over a year at a temperature range of −12° to −16° C., was used for feeding. At the time of collection it was noticed that the young birds were being fed exclusively on salmon brought to them from the beaches or from the refuse dumps of nearby canneries. Since there were no lakes nearby where infected fishes could be obtained, this seemed to preclude preinfection by *Diphyllobothrium* sp. The literature does not report, so far as the writer is aware, that this fish species harbors the plerocercoids of any species of *Diphyllobothrium*; consequently, the feeding of salmon by the gulls to their young would not seem to have any bearing on this experiment. The fact that our salmon had been stored for such a length of time at low temperatures made it highly improbable that larval cysts, if present, could still be viable.[1] During the first week of captivity, the young gulls were fed small pieces of salmon every three hours. The frequency of feeding was reduced with the age and the development of the birds.

Plerocercoids for the experiment (muscular and visceral in location) were recovered from rainbow trout, *Salmo gairdnerii* Richardson, taken from Daniels Lake on the Kenai Peninsula. The fishes of this lake had been previously studied by us and were known to be infected with *Diphyllobothrium* sp.[2] On July 7 viable plerocercoids were fed to the young gulls as follows: Each of the birds in cages A and B (see Table 1) received five visceral cysts and those in cages D and E received muscular cysts—three and four larvae each, respectively. The third bird of cage E (no. 14), after having seized some infected fish which was not intended for him, was rewarded with the entire fish; thus an unknown number of larvae was given in this case. On July 15 the experimental feeding of the birds in cages A and D was repeated, with each receiving the same number of larvae as before. At this time, both of the gulls in cage C were infected with five visceral cysts, making a total of 14 artificially infected birds. Autopsy of the young gulls was begun on the second day after the last infection and continued through the twenty-fourth day (see Table 1).

RESULTS AND DISCUSSION

As may be noted from the table, seven gulls, or 50 percent, were found to be infected with *Diphyllobothrium* sp.; this included two of the eight birds that had received visceral cysts and five of the six that had received muscular cysts. It is probably incidental that those receiving muscular cysts showed a higher degree of infection. None of the birds in cage A was infected, despite their having received the most larvae. The small number of birds involved does not, however, permit any conclusions. Segment counts of three 13-day-old strobilae gave an average of 333. This figure may serve to indicate the rapid rate

Table 1—Experimental Infection of Gulls with Diphyllobothrium sp.[1]

Host No.	Date of infection		Number of larvae administered	Larval type		Days elapsing before autopsy	Number of worms recovered
	July 7	July 15		Muscle	Visceral		
Cage A							
1	X	X	10		X	2	0
2	X	X	10		X	6	0
3	X	X	10		X	24	0
Cage B							
4	X		5		X	2	0
5	X		5		X	6	0
6	X		5		X	13	0
Cage C							
7		X	5		X	7	2
8		X	5		X	12	4
Cage D							
9	X	X	6	X		2	3
10	X	X	6	X		6	3
11	X	X	6	X		24	1
Cage E							
12	X		8	X		2	6
13	X		8	X		6	0
14	X		?	X	X	13	37

[1] Thirty-seven controls, negative for helminth parasites, are not included in table.

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[1] Kjava (1913), as quoted in Magath and Essex (1931) stated that submitting infected fish to a temperature of −9° C. for 24 to 48 hours kills the larvae of *D. latum*; this was confirmed by the latter authors.

[2] This had been determined by morphological study of adult worms obtained through feeding plerocercoids to certain mammalian hosts.

of growth. All worms recovered were fixed, stained, and mounted for morphological study.

Macroscopic examination of the specimens of *Diphyllobothrium* sp. recovered from artificially infected gulls, as well as those from dogs, foxes, bears, and man, reveals a great range of variation in gross appearance. Possibly the host species involved, its physiological condition, and the age of the worm may be the primary determining factors in the morphological variation of the adult form. Stunkard (1949) pointed out that "species now included in the genus constitute a heterogeneous collection, from a variety of hosts and bionomic areas, but the morphological diversity is so distributed among the species and so many different combinations of characters exist that the arrangement of the species into related groups must await further information." Rausch (1951) stated, "Speciation on the basis of morphological characters of tapeworms of the genus *Diphyllobothrium* is impossible for the Alaskan forms." These statements indicate that a new approach, rather than a taxonomic one, must be made to the problem of speciation of the worms of this genus.

The successful infection of gulls with *Diphyllobothrium* sp. considerably complicates the problem of control of this helminth in Alaska. Bent (1921), in connection with the glaucous-winged gull, wrote, "This is the most abundant, the most widely distributed, and characteristic gull of the north Pacific coast . . ." The vast numbers of these birds, coupled with their potential for disseminating viable eggs over a wide area will undoubtedly enhance the chances of survival of this parasite in Alaska. Terrestrial mammals which utilize fishes for food also constitute an important reservoir of infection, but nevertheless this is one which probably could be controlled locally if diphyllobothriasis were ever thought important enough to human health to justify extreme measures.

The low living standard of the Alaskan native often compels him to depend on fish almost exclusively or at least as a substantial part of his diet. Local customs and the conditions under which many of these people live necessitate the eating of raw or poorly cooked fish. Preliminary surveys made to date reveal that the percentage-incidence of infection among the natives in certain areas where *Diphyllobothrium* sp. is endemic is quite high. Hitchcock[3] (1950; 1951), during her parasitological investigations of the Bethel and Kotzebue areas, found an incidence of infection of 15 and 6 percent, respectively. Although the pathogenicity of *Diphyllobothrium* is not well understood, it seems probable that the disease may aggravate, in areas where it is endemic, the present serious health condition of Alaskan natives. Consequently, diphyllobothriasis must be regarded as a definite public health problem in Alaska.

A more intensified investigation of the immunological characteristics of this parasite in native birds and mammals in Alaska will be undertaken during the field season of 1952.

SUMMARY

The experimental infection of glaucous-winged gulls (*Larus glaucescens*) with *Diphyllobothrium* sp. has been accomplished. All available evidence indicates that this Alaskan species readily infects gulls, various wild carnivorous mammals, and man. The specific identity of this cestode has not been determined.

LITERATURE CITED

BENT, A. C. *Life histories of North American gulls and terns.* U. S. Nat. Mus. Bull. **113:** 345 pp. 1921.

HITCHCOCK, D. J. *Parasitological study on the Eskimos in the Bethel area of Alaska.* Journ. Parasit. **36:** 232–234. 1950.

———. *Parasitological study on the Eskimos in the Kotzebue area of Alaska.* Journ. Parasit. **37:** 309–311. 1951.

MAGATH, T. B., AND ESSEX, H. E. *Concerning the distribution of* Diphyllobothrium latum *in North America.* Journ. Prev. Med. **5:** 227–242. 1931.

RAUSCH, R. *Biotic interrelationships of helminth parasitism.* Public Health Repts. **66:** (29): 928–934. 1951.

STUNKARD, H. W. Diphyllobothrium stemmacephalum *Cobbold, 1858, and* D. latum (*Linn., 1758*). Journ. Parasit. **35:** 613–624. 1949.

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[3] Miss Hitchcock was employed as a consultant for the Arctic Health Research Center at the time these surveys were made.

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PALEONTOLOGY.—*The ostracode genus* Hemicythere *and its allies.* HARBANS S. PURI,[1] Florida Geological Survey. (Communicated by Alfred R. Loeblich, Jr.)

Hemicythere is a common ostracode genus occurring in the Cenozoic of North America; 27 species and a variety have so far been reported from North America, and 23 of these are valid. The genus is of considerable importance because of the stratigraphic significance of its species which could be easily used as excellent markers.

Five species, *H. arenicola* (Cushman), *H. concinna* (Jones), *H. crenulata* (Sars), *H. truitti* Tressler and Smith, and *H. strandentia* Tressler and Smith have been reported from the Atlantic Ocean. Eight species, *H. punctistriata* (Ulrich and Bassler), *H. confragosa* Edwards, *H. minuta* Edwards, *H. laevicula* Edwards, *H. conradi* Howe and McGuirt, *H. sellardsi* Howe and Neill, *H. calhounensis* Smith, and *H. dalli* Howe and Brown, and *H. dalli redbayensis* Howe and Brown have been described from the Miocene of the Gulf Coastal Plain. *H. dalli* and *H. dalli redbayensis* belong to *Cythromorpha* Hirschmann, *H. sellardsi* to *Caudites* Coryell and Fields, and *H. calhounensis* to *Procythereis* Skogsberg. *H. antillea* Van den Bold has been reported from the West Indies Miocene. *H. saginata* Stephenson and *H. amygdala* Stephenson have been reported from the Oligocene *Marginulina-Heterostegina-Discorbis* zones, and *H. kniffeni* Howe and Law from the Mariana Oligocene. Seven species, *H. phrygionia* Howe, *H. lienosa* Howe, *H. cribraria* Howe, *H. bellula* Howe, *H. mota* Howe, *H. aleatoria* Howe, and *H. lemniscata* Howe have been reported from the middle Eocene Avon Park limestone of Florida. Two species, *H. symmetrica* Van den Bold and *H. limbata* (Bosquet), have been reported from the Eocene of the West Indies. To amplify the characters of *Hemicythere* the genus is redescribed and its genotype, *H. villosa* (Sars) figured. A new species, *H. howei*, is described from the Miocene of Western Florida. The exact stratigraphic range of all the species of *Hemicythere* so far reported from North America is shown in the accompanying chart.

HISTORY OF THE GENUS HEMICYTHERE AND ITS ALLIES

The genus *Hemicythere* was proposed by Sars (1925, p. 182) to include a number of species previously referred to *Cythereis* Jones and *Cythere* Müller. Sars placed the genus in an intermediate position between *Cythereis* and *Cythere*; closer in some respects to the latter. Sars did not designate a genotype but instead based the description of *Hemicythere* on eight Recent species from Norway, listed in order: *Cythere villosa* Sars, *Cythereis emarginata* Sars, *C. crenulata* Sars, *C. finmarchia* Sars, *Cythere quadridentata* Baird, *Cythereis angulata* Sars, *Cythere latimarginata* Speyer, *C. concinna* Jones, and *C. oblonga* Brady. As regards the generic characters of the carapace Sars (*op. cit.* p. 182) observed:

> Shell of very solid consistency, calcareous, resembling somewhat in shape that of *Cythere*. Valves more or less unequal, with the surface distinctly pitted or roughly reticulate, marginal zone closely striated, edges densely hairy in front. Hinge with closing teeth well developed. Eyes distinctly separated.

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Blake (1933, p. 234) contended that *Hemicythere* be reduced to a subgeneric rank. Its generic nature has been estabilshed by Howe (1935, p. 27), Edwards (1944, p. 517), and subsequent authors. Edwards (*op. cit.*) designated *Cythere villosa* Sars (1865, p. 42)—first of the eight species described by Sars—as genotype.

Skogsberg (1928) divided what he supposed to be the genus *Cythereis* Jones into three subgenera: *Procythereis, Cythereis,* and *Pseudocythereis. Cythereis,* however, as shown by Triebel (1940), is a Cretaceous form. Forms included by Skogsberg under *Procythereis* actually belong to *Hemicythere.* Skogsberg thought it impossible to subdivide the genus "*Cythereis*" on the basis of shape and structure of the shell. He instead based his subgenera on the structure of the appendages and of the penis. Structure of the penis appeared to be more significant to Skogsberg (*op. cit.* p. 16) who thought this organ to have been the "seat of the initial morphological changes leading to speciation." Skogsberg did not give any shell description of the subgenus *Procythereis* since the carapace was broken in most of the specimens examined by him. He recognized two groups—*Torquata* and *Radiata* within *Procythereis*, characterised by "the shape and structure of the penis and by the course of the ductus in the genital verruca of the female." *Procythereis* shows sufficiently distinct characters to deserve a generic rank and is represented by *H. calhounensis* Smith from the Chipola Miocene. Skogsberg's description of the carapace of *Pseudocythereis* is lacking. However, it is clear from the description and figures of the subgenotype, *Cythereis* (*Pseudocythereis*) *spinifera* Skogsberg, that he was dealing with a form closer to *Paracytheretta* Triebel than *Hemicythere*. Forms included under the subgenus *Cythereis* by Skogsberg belong to a new genus and will be described in another paper.

Neviani (1928, pp. 72, 94) described "gruppo" (subgenus) *Auris* under "*Cythereis*". No genotype was designated by Neviani, and his description was based on the following 10 species, all from the Pliocene of Italy: *Cythere speyeri* Brady, *Cythereis* (*Auris*) *subspeyeri* Neviani, *Cypridina similis* Reuss, *Cytherina haueri* Roemer, *Cythere punctata* Münster, *Cythere venus* Seguenza, *Cythereis villosa* Sars, *Cythereis marsupis* Neviani, *Cythereis* (*Auris*) *micrometrica* Neviani, and *Cythereis* (*Auris*) *distinguenda* (new name for *Cythere oblonga* Brady, 1866, *not Cythere oblonga* McCoy, 1844). Neviani's figures appear to be *Hemicythere*, and he even included in *Auris*, *Cythereis villosa* Sars, the genotype of *Hemicythere. Auris* is here considered to be a synonym of *Hemicythere.*

The genus *Caudites* was proposed by Coryell and Fields (1937, pp. 10, 11) to include *Hemicythere*-like thick-shelled elongate, subtriangular forms with a thickened anterior rim and additional longitudinal and dorsal ridges. The genotype is *C. medialis* Coryell and Fields. *Hemicythere sellardsi* Howe and Neill belong to this genus. Only five species of this genus are known from North America and their distribution is shown in the accompanying table. A new species, *C. chipolensis* is described from the Chipola Miocene.

Elofson (1941, pp. 288, 289) described *Paracythereis* and *Heterocythereis* as subgenera of "*Cythereis*" (really of *Hemicythere*). The name *Paracytheris* is preoccupied by Jennings (1936, pp. 55, 56) and is therefore invalid. The group Elofson described consists of two species *C. concinna* Jones and *C. latimarginata* Speyer, both of which Sars (1925, pp. 188, 189) considered to be *Hemicythere*. Sars's (*op. cit.*) and Brady's (1868) figures, however, do not agree with Jones's (1857). Since Elofson neither described nor figured the carapace of his subgenotype *C. concinna* Jones, the author does not know for sure which *C. concinna* he referred to. Both of these species are here retained in the genus *Hemicythere* until Elofson's types could be examined. The carapace in *Heterocythereis* is quite similar to that of *Hemicythere* but is relatively thin and smooth. The muscle scar pattern of the subgenotype, *Cythere albomaculata* (Baird), is rather distinctive and consists of a vertical row of five scars, the spots immediately below the top being a pair; in front of the upper end of this row is another oblique row of three smaller scars. *Heterocythereis* is here raised to a generic rank.

Elofson (*op. cit.*) placed under *Eucythereis* Klie (1940) *Cythereis angulata* Sars, *Cythere convexa* Baird, *C. crenulata* Sars, *Cythereis emarginata* Sars, and *C. villosa* Sars. All these species are good *Hemicythere* and since Elofson included in *Eucythereis* even the genotype of *Hemicythere, Cythereis villosa, Eucythereis* of Elofson is here considered as a synonym of *Hemicythere.*

Two homeomorphic genera, *Cnestocythere* and *Schizocythere*, externally very much like *Hemicythere* but radically different in hinge structure and course of selvage are reported by Triebel (1950). Neither of these genera have as yet been discovered in the American Tertiaries.

Howe (1951, p. 17) described a new genus, *Urocythere,* from the middle Eocene Avon Park limestone of Florida with *U. attenuata* Howe as its genotype. This genus has the outline of *Caudites* Coryell and Fields but does not possess the surface ornamentation. It is more elongate than *Hemicythere* Sars, lacks the reticulate ornamentation and differs radically in the hinge structure and radial pore canals.

Hemicythere has hitherto been placed in the subfamily Cytherinae Dana. Sylvester-Bradley (1948, p. 793) included it in the family Trachyleberidae. In the opinion of the author the two genera, *Trachyleberis* and *Hemicythere,* are not nearly related and can not be included in Trachyleberidae. A new subfamily, Hemicytherinae, in the family Cytheridae Baird, is here proposed for the reception of the following related genera, with *Hemicythere* as its type genus: *Hemicythere* Sars, *Procythereis* Skosberg, *Caudites* Coryell and Fields, *Heterocythereis* Elofson, and *Urocythere* Howe.

LIST OF LOCALITIES

Listed below are the localities from which samples used were collected. References to locations contained in the text are indicated by the index number which precedes each entry.

1. Chipola, NE¼ NE¼ sec. 20, T. 1 N., R. 16 W., Washington County, Fla.
2. Chipola. SE¼ SE¼ sec. 8, T. 3 N., R. 16 W., Chimney Quarry, Washington County, Fla.
3. Chipola. SE¼ SE¼ sec. 5, T. 1 N., R. 16 W., Washington County, Fla.
4. Chipola. 1 mile below Scott's Bridge, NE¼ sec. 27, T. 2 N., R. 12 W., Bay County, Fla.
5. Chipola. In a ravine 200 yards east of Holmes Creek, NW¼ NE¼ sec. 28. T. 2 N., R. 16 W., Washington County, Fla.
6. Chipola. 220 yards below Walsingham Bridge, NE¼ sec. 15, T. 1 N., R. 13 W., Washington County, Fla.
7. Chipola. 1 mile below Gainer's Bridge, NW¼ sec. 34, T. 1 N., R. 13 W., Washington County, Fla.
8. Chipola. 1¾ miles below Scott's Bridge over Econfina Creek, NE ¼ NW¼ sec. 28, T. 2 N., R. 12 W., Bay County, Fla.
9. Chipola. At Red Hill Still, NE¼ NW¼ sec. 20, T. 1 N., R. 16 W., Washington County Fla.
10. Chipola. Lassiter Landing on Choctawhatchee River, SE¼ SE¼ sec. 13, T. 2 N., R. 17 W., Washington County, Fla.
11. Chipola. Ten Mile Creek, 4 miles south of Willis, Calhoun County, Fla.
12. Type Chipola. Ten Mile Creek, from bridge to ½ mile below bridge on the Mariana-Clarksville Road, 2376 feet south of NW corner of sec. 12, T. 1 N., R. 10 W., 22 miles south of Marianna, Calhoun County, Fla.
13. Chipola. NE¼ SW¼ sec. 28, T. 2N., R. 16 W., Washington County, Fla.
14. Chipola. SW¼ NE¼ sec. 31, T. 2 N., R. 16 W., Washington County, Fla.
15. Type Oak Grove. At old sawmill near Oak Grove on right bank of Yellow River, 300 feet south of NW corner of NE¼ NE¼ sec. 20, T. 5 N., R. 23 W., about 100 yards below bridge on Laurel Hill-Oak Grove road, Okaloosa County, Fla.
16. Oak Grove. Senterfiet's or Tanner's Mill (abandoned), sec. 14, T. 5 N., R. 23 W., 4 miles southwest of Laurel Hill, Okaloosa County, Fla.
17. Shoal River. Small gully, 50 feet south of road and 150 feet east of bridge over White's Creek on Eucheeanna-Knox Hill Road, NE¼ SE¼ SW¼ sec. 23, T. 2 N., R. 18 W., one mile west of Valley Church, Walton County, Fla.
18. Type Shoal River. Small branch ¼ mile southwest of residence of J.T.G. McClellan, SE¼ NW¼ sec. 4, T. 3 N., R. 21 W., about ⅜ mile west of shell bluff, Walton County, Fla.
19. Shoal River. Bottom of old fluorspar prospect shaft at a depth of 50 to 55 feet, about 4½ miles south of Argyle, Walton County, Fla.
20. Shoal River. Under bridge over Shoal River, 2¾ miles north of Mossyhead, SE corner of sec. 35, T. 4 N., R. 21 W., Walton County, Fla.
21. Type *Yoldia* zone. Frazier's farm (formerly Spencer farm), SE¼ sec. 18, T. 2 N., R. 19 W., Walton County, Fla.
22. *Yoldia* zone. Chester Spence farm, NE¼ NE¼ sec. 17, T. 2 N., R. 19 W., Walton County, Fla.
23. *Arca* zone. Road cut leading to an abandoned bridge on east bank of Alaqua Creek on Permenter's farm, sec. 17, T. 1 N., R. 19 W., Walton County, Fla.
24. *Arca* zone. W. E. Collin's farm, SE¼ NE¼ sec. 15, T. 2 N., R. 15 W., Washington County, Fla.
25. *Arca* zone. SW¼ NE¼ SW¼ sec. 16, T. 2 N., R. 15 W., Washington County, Fla.
26. *Arca* zone. NW¼ SE¼ sec. 16, T. 2 N., R. 15 W., spring head 100 yards east of road, Washington County, Fla.
27. *Arca* zone. SW¼ NW¼ sec. 15, T. 2 N., R. 15 W., Washington County, Fla.
28. *Arca* zone. SE¼ SW¼ NE¼ sec. 15, T. 2 N., R. 15 W., Washington County, Fla.
29. *Arca* zone. NW¼ SW¼ sec. 15, T. 2 N., R. 15 W., Washington County, Fla.
30. *Arca* zone. NE¼ SW¼ sec. 16, T. 2 N., R. 15 W., Washington County, Fla.
31. *Arca* zone. Flournoy's old mill, NE¼ NE¼ sec. 34, T. 3 N., R. 18 W., Holmes County, Fla.
32. *Arca* zone. In a steephead in the SW¼ NE¼ SW¼ sec. 16, T. 2 N., R. 15 W., along a small

ravine running west into south-side branch, Washington County, Fla.

33. *Arca* zone. Jim Kennedy Branch, 1 mile east of Red Bay, Walton County, Fla.
34. *Arca* zone. John Anderson's farm, sec. 10. T. 2 N., R. 17 W., ¾ mile east of Red Bay, Walton County, Fla.
35. *Arca* zone. At small spring head in E. Gomillion's field near Red Bay, Walton County, Fla.
36. Choctawhatchee. Pit of West Florida Power Co., just east of road at Power Dam, about 300 feet east of the Hydroelectric power plant near Ward, Liberty County, Fla.
37. *Ecphora* zone? 300 feet above Walsingham Bridge over Econfina Creek, NE¼ sec. 15, T. 1 N., R. 13 W., Washington County, Fla.
38. *Ecphora* zone. ¼ mile above Walsingham Bridge, SW¼ sec. 11, T. 1 N., R. 13 W., Washington County, Fla.
39. *Ecphora* zone. ¼ mile above Walsingham Bridge, SE¼ sec. 10, T. 1 N., R. 13 W., Washington County, Fla.
40. *Ecphora* zone? 220 yards above Walsingham Bridge, Econfina Creek, NE¼ sec. 15, T. 1 N., R. 13 W., Washington County, Fla.
41. *Ecphora* zone. Jackson Bluff, near top of section, Ocklocknee River, Leon County, Fla.
42. *Ecphora* zone. Jackson Bluff, Top shell bed, Ocklocknee River, Leon County, Fla.
43. *Ecphora* zone. *Pecten* Bed. Jackson Bluff, Ocklocknee River, Leon County, Fla.
44. *Ecphora* zone. Jackson Bluff, Ocklocknee River, Leon County, Fla.
45. *Ecphora* zone. Upper shell bed at Alum Bluff on the east side of the Apalachicola River, S½ NE¼ sec. 24, T. 1 N., R. 8 W., about 4 miles north of Bristol, Liberty County, Fla.
46. *Ecphora* zone. Cut in road leading to Watson's Landing, about 2 miles north of Alum Bluff and the same distance from the Apalachicola River. 2000 feet north and 100 feet west of SE corner of sec. 7, T. 1 N., R. 7 W., Liberty County, Fla.
47. *Ecphora* zone. Harvey Creek, ½ mile above old well at "Swimming Hole," 5 feet below water, Leon County, Fla.
48. *Cancellaria* zone. Gully pond, southeast of Greenhead, Washington County, Fla., on the Sales-Davis Lumber Co. property in the center of N½ NW¼ NE¼ sec. 14, T. 1 N., R. 14 W., at approximate elevation of 59 feet.
49. *Cancellaria* zone. 1 mile above Walsingham Bridge over Econfina Creek, NW¼ SW¼ sec. 11, T. 1 N., R. 13 W., Washington County, Fla.
50. *Cancellaria* zone. ¼ mile below Gainer's Bridge, Econfina Creek, SW¼ SE¼ sec. 33, T. 1 N., R. 13 W., Washington County, Fla.
51. *Cancellaria* zone. Borrow pit just east of the power dam at Jackson Bluff, Ocklocknee River, 500 feet east of NW corner, sec. 21, T. 1 S., R. 4 W., Leon County, Fla.
52. *Cancellaria* zone. NE¼ sec. 16, T. 1 S., R. 13 W., on Moccasin Creek beneath bridge, Bay County, Fla.
53. *Cancellaria* zone. Blue Sink, corner of NE¼ sec. 14, T. 1 N., R. 14 W., Washington County, Fla.
54. *Cancellaria* zone. ⅜ mile above Gainer's Bridge on Econfina Creek, NE¼ SE¼ sec. 33, T. 1 N., R. 13 W., Washington County, Fla.
55. *Cancellaria* zone. ½ mile above Gainer's Bridge on Econfina Creek, SE¼ NE¼ sec. 33, T. 1 N., R. 13 W., Washington County, Fla.
56. *Cancellaria* zone. In a small stream south of and under Gainer's Bridge in SW¼ SE¼ sec. 33, T. 1 N., R. 13 W., Washington County, Fla.
57. *Cancellaria* zone. In a small sink south of a community road in NW¼ SW¼ sec. 7, T. 1 N., R. 13 W., Washington County, Fla.
58. *Cancellaria* zone. Clarke's Pond, NE¼ SE¼ SW¼ sec. 12, T. 1 N., R. 12 W., Washington County, Fla.
59. Recent. Shore sand, Dogs Bay, near Roundstone County, Galway, Ireland. Arther Earland collection.

SYSTEMATIC DESCRIPTIONS

Order Ostracoda Latreille

Suborder Podocopa Sars

Family Cytheridae Baird

Hemicytherinae Puri, n. subfam.

Type genus: *Hemicythere* Sars.

Carapace of firm consistancy, calcareous, usually somewhat almond-shaped, smooth, pitted, reticulate or with longitudinal and dorsal ridges; valves inequal. Hinge of right valve with knob-like anterior tooth, postjacent socket which is continued as a groove to an outwardly directed tooth at the posterior cardinal angle. Pore canals numerous, long, closely spaced. Muscle scar pattern consists of a vertical row of four with additional three or four scars in an oblique row situated anteriorly.

The subfamily comprises the following genera: *Hemicythere* Sars, *Procythereis* Skogsberg, *Caudites* Coryell and Fields, *Heterocythereis* Elofson, and *Urocythere* Howe.

Genus **Hemicythere** Sars

Hemicythere Sars, 1925, p. 182; Klie, 1929, p. 282; Tressler, 1941, p. 100; Edwards, 1944, p. 517; Van den Bold, 1946, p. 28.

Auris Neviani, 1928, pp. 72, 94.

Genotype (by subsequent designation by Edwards, 1944): *Cythere villosa* Sars, 1865, p. 42. Recent, Norway.

Carpace usually almond-shaped, solid, with a semiconcave posterior dorsal margin; smooth pitted or reticulate; valves usually unequal in size.

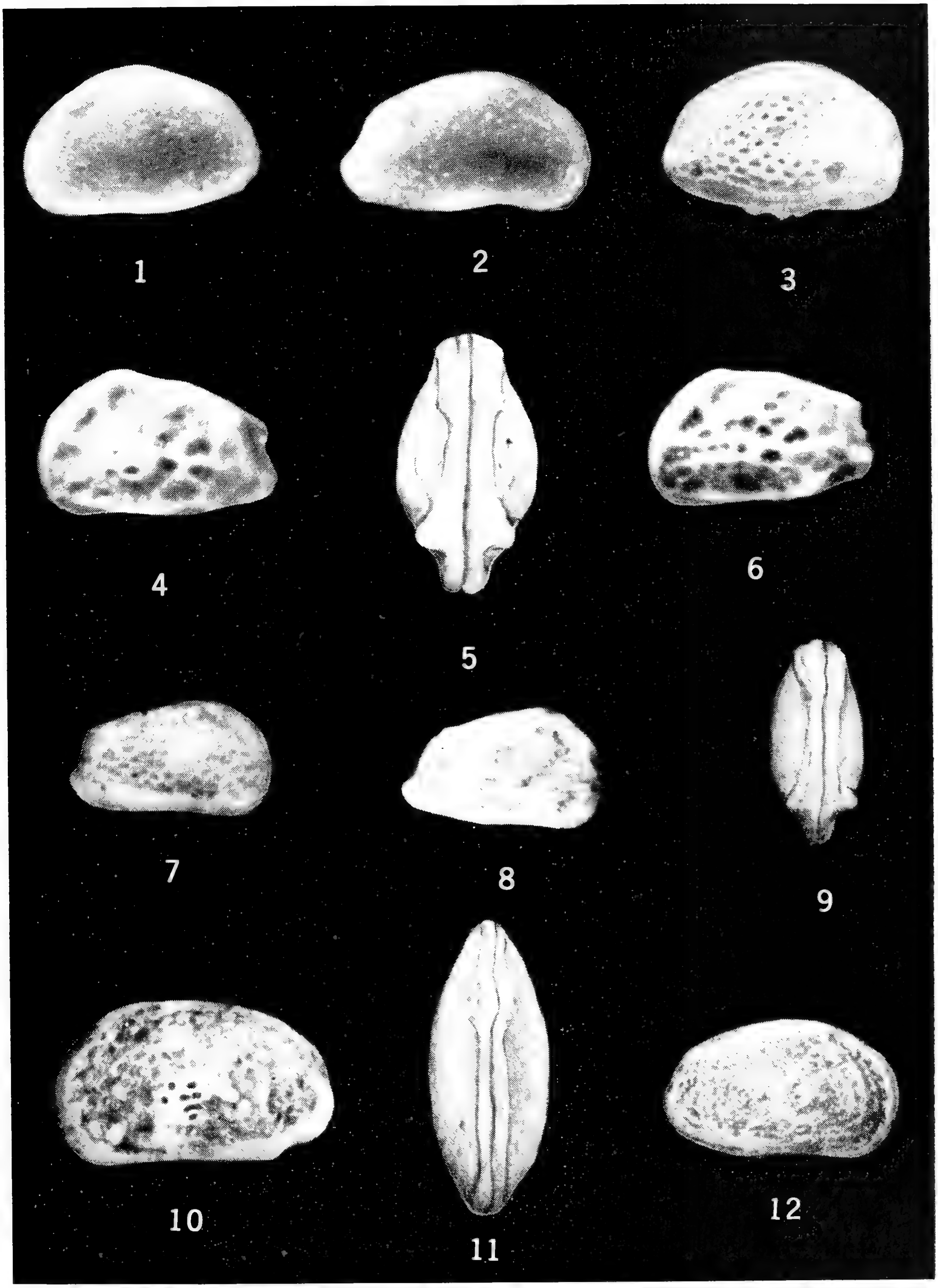

Plate 1.—Genus *Hemicythere*. All figures × 67.5. Specimen numbers refer to the Henry V. Howe type collection at the Louisiana State University. Figs. 1, 2, *Hemicythere laevicula* Edwards, locality 42 (1, left valve, plesiotype no. 2467; 2, right valve, plesiotype no. 2468); Fig. 3, *H. amygdala* Stephenson, locality 1 (right valve view of a complete carapace, plesiotype no. 2469); Figs. 4–6, *H. confragosa* Edwards (4, left valve view of a complete carapace, plesiotype no. 2470, locality 42; 5, dorsal view of a complete carapace, plesiotype no. 2471, locality 43; 6, left valve, plesiotype no. 2472, locality 43); Figs. 7–9, ***H. howei*** Puri, n. sp. (7, right valve view, holotype no. 2473, locality 27; 8, right valve view of a complete specimen, paratype no. 2474, locality 43; 9, dorsal view of paratype no. 2474); Figs. 10–12, *H. villosa* (Sars), locality 59 (10, left valve, plesiotype no. 2475; 11, dorsal view of a complete carapace, plesiotype no. 2476; 12, right valve, plesiotype no. 2477).

Hinge of the right with a knoblike anterior tooth, broad postjacent socket which is continued as a strong, outwardly directed tooth at posterior cardinal angle. Marginal area broad; inner margin and line of concrescence coincide; pore canals numerous, closely spaced, nearly straight. Muscle scar pattern consists of a vertical row of five scars with additional two to three scars situated anteriorly.

Range: Eocene to Recent.

The following species are considered to be good *Hemicythere:*

- *H. amygdala* Stephenson, 1944, p. 158.
- *H. angulata* (Sars) (*Cythere angulata* Sars, 1865, p. 46).
- *H. antillea* Van den Bold, 1946, p. 101.
- *H. arenicola* (Cushman) (*Cythereis arenicola* Cushman, 1906, p. 379).
- *H. balatonica* (Zalanyi) (*Cythereis balatonica* Zalanyi, 1913, p. 126).
- *H. borealis* (Brady) (*Cythere borealis* Brady, 1868, p. 31).
- *H. brunnea* (Brady) (*Cythere brunnea* Brady, 1898, p. 442).
- *H. californiensis* Le Roy, 1943, p. 366.
- *H. californiensis hispida* Le Roy, 1943, p. 367.
- *H. cimbaeformis* (Seguenza) (*Cythere cimbaeformis* Seguenza, 1882, p. 22).
- *H. concinna* (Jones) (*Cythere concinna* Jones, 1857, p. 29).
- *H. confragosa* Edwards, 1944, p. 518.
- *H. conradi* Howe and McGuirt, in Howe *et al.*, 1935, p. 27.
- *H. convexa* (Baird) (*Cythere convexa* Baird, 1850, p. 174).
- *H. convexa turgida* (Zalanyi) (*Cythere convexa turgida* Zalanyi, 1913, p. 126).
- *H. crenulata* (Sars) (*Cythere crenulata* Sars, 1865, p. 39).
- *H. emarginata* (Sars) (*Cythereis emarginata* Sars, 1865, p. 38).
- *H. expunctata* (Zalanyi) (*Cythereis expunctata* Zalanyi, 1913, p. 126).
- *H. finmarchica* (Sars) (*Cythereis finmarchica* Sars, 1865, p. 41).
- *H. jollaensis* LeRoy, 1943, p. 365.
- *H. kerguelensis* (Brady) (*Cythere kerguelensis* Brady, 1880, p. 78).
- *H. kniffeni* Howe and Law, 1936, p. 67.
- *H. kolesnikovi* (Schneider) (*Cythereis kolesnikovi* Schneider, 1939, p. 198).
- *H. laevicula* Edwards, 1944, p. 518.
- *H. latimarginata* (Speyer) (*Cythere latimarginata* Speyer, 1863, p. 22).
- *H. lattorfiana* (Lienenklaus) (*Cythereis lattorfiana* Lienenklaus, 1900, p. 513).
- *H. limbata* (Bosquet) (*Cythere limbata* Bosquet, 1852, p. 78).
- *H. margaritifera* (G. W. Müller) (*Cythereis margaritifera* G. W. Müller, 1894, p. 368).
- *H. marginata* (Norman) (*Cythere marginata* Norman, 1862, p. 47).
- *H. mehesi* (Zalanyi) (*Cythereis mehesi* Zalanyi, 1913).
- *H. merita* (Zalanyi) (*Cythereis merita* Zalanyi, 1913).
- *H. minuta* Edwards, 1944, p. 519.
- *H. oblonga* (Brady) (*Cythere oblonga* Brady, 1866, p. 373, not *Cythere oblonga* McCoy, 1844) = *Cythereis* (*Auris*) *distingueda* Neviani, 1928 (new name for *Cythere oblonga* Brady, 1866).
- *H. palosensis* LeRoy, 1943, p. 365.
- *H. perforata* (Zalanyi) (*Cythereis perforata* Zalanyi, 1913, p. 141).
- *H. pulchella* (Brady) (*Cythere pulchella* Brady, 1868, p. 404).
- *H. punctistriata* (Ulrich and Bassler) (*Cythere punctistriata* Ulrich and Bassler, 1904, p. 108).
- *H. quadridentata* (Baird) (*Cythere quadridentata* Baird, 1850, p. 413).
- *H. saginata* Stephenson, 1944, p. 158.
- *H. sarmatica* (Zalanyi) (*Cythereis sarmatica* Zalanyi, 1913, p. 127).
- *H. schreteri* (Zalanyi) (*Cythereis schreteri* Zalanyi, 1913, p. 130).
- *H. speyeri* (Brady) (*Cythere speyeri* Brady, 1868, p. 222).
- *H. stolonifera* (Brady) (*Cythere stolonifera* Brady, 1880, p. 89).
- *H. strandentia* Tressler and Smith, 1948, p. 19.
- *H. subangusta* (Zalanyi) (*Cythereis subangusta* Zalanyi, 1913).
- *H. symmetrica* Van den Bold, 1946, p. 102.
- *H. truitti* Tressler and Smith, 1948, p. 18.
- *H. villosa* (Sars) (*Cythereis villosa* Sars, 1865, p. 42).

The following species have been erroneously assigned to *Hemicythere:*

- *H. calhounensis* Smith, 1941, p. 280.
- *H. dalli* Howe and Brown, in Howe *et al.*, 1935, p. 28.
- *H. dalli redbayensis* Howe and Brown, in Howe *et al.*, 1935, p. 29.
- *H. sellardsi* Howe and Neill, in Howe *et al.*, 1935, p. 29.

Hemicythere laevicula Edwards

Pl. 1, Figs. 1, 2

Hemicythere laevicula Edwards, 1944, p. 518, pl. 86, figs. 27–30.

This species was originally described from the Duplin marl of North Carolina. It is very close to *H. conradi* but differs in its less strong ornamentation and somewhat elongate nature of the carapace.

Dimensions of the plesiotype no. 2468, a right valve: Length 0.625 mm; height 0.371 mm; plesiotype no. 2467, a left valve: Length 0.608 mm; height 0.371 mm. Both the figured specimens came from locality 42. This species also occurs at *Ecphora* zone localities 39, 41, and 47 and *Arca* zone locality 27 and questionably at locality 30.

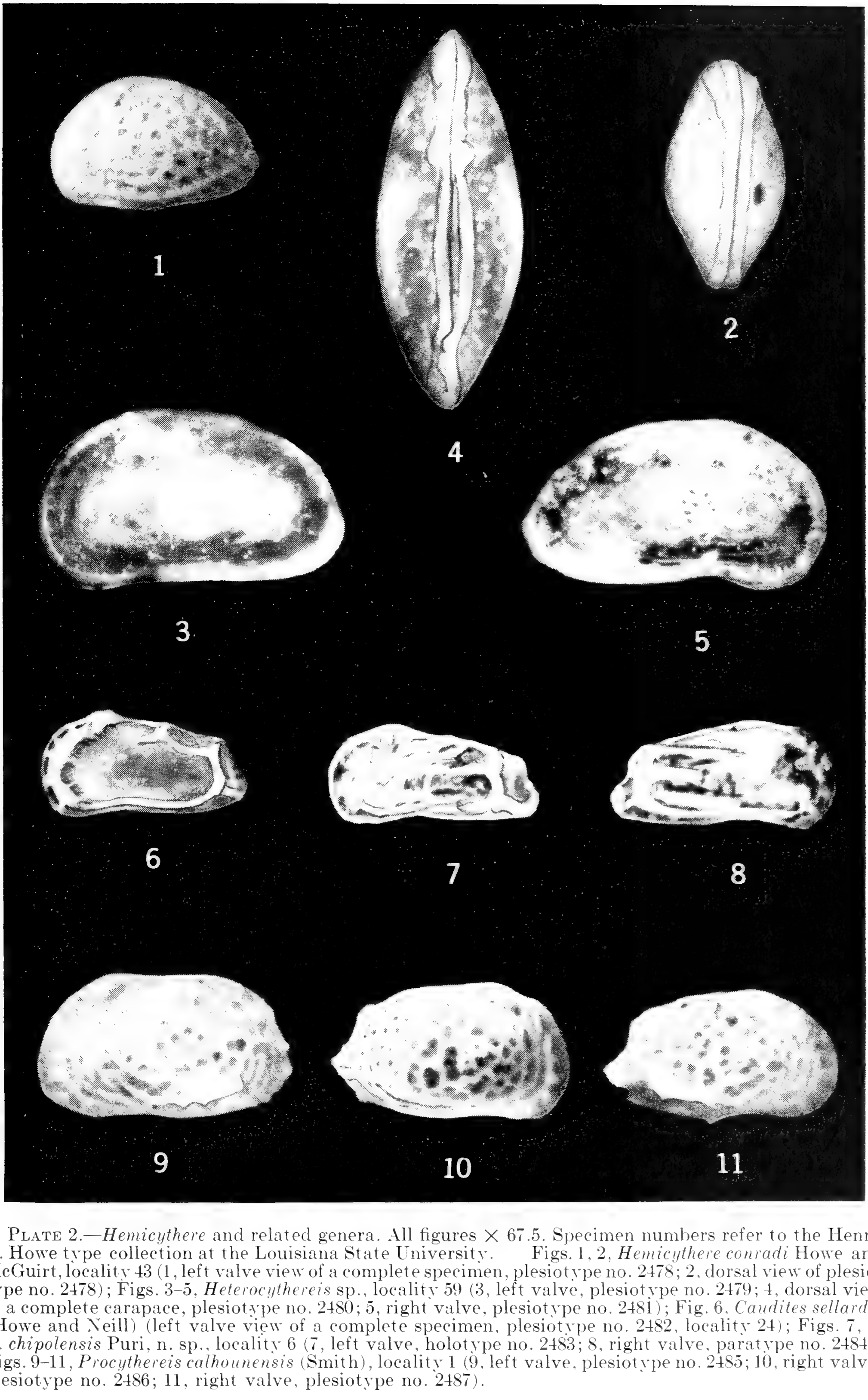

Plate 2.—*Hemicythere* and related genera. All figures × 67.5. Specimen numbers refer to the Henry V. Howe type collection at the Louisiana State University. Figs. 1, 2, *Hemicythere conradi* Howe and McGuirt, locality 43 (1, left valve view of a complete specimen, plesiotype no. 2478; 2, dorsal view of plesiotype no. 2478); Figs. 3–5, *Heterocythereis* sp., locality 59 (3, left valve, plesiotype no. 2479; 4, dorsal view of a complete carapace, plesiotype no. 2480; 5, right valve, plesiotype no. 2481); Fig. 6. *Caudites sellardsi* (Howe and Neill) (left valve view of a complete specimen, plesiotype no. 2482, locality 24); Figs. 7, 8, *C. chipolensis* Puri, n. sp., locality 6 (7, left valve, holotype no. 2483; 8, right valve, paratype no. 2484); Figs. 9–11, *Procythereis calhounensis* (Smith), locality 1 (9, left valve, plesiotype no. 2485; 10, right valve, plesiotype no. 2486; 11, right valve, plesiotype no. 2487).

Hemicythere conradi Howe and McGuirt
Pl. 2, Figs. 1, 2

Hemicythere conradi Howe and McGuirt, in Howe *et al.*, 1935, p. 27, pl. 3, figs. 31–34, pl. 4, fig. 17; Edwards, 1944, p. 518, pl. 86, figs. 17, 18.

Carapace small, subovate in side view. Dorsal margin moderately arched, ventral margin slightly concave near the middle. Anterior end broadly rounded below, obliquely rounded dorsally; posterior end narrow and compressed. Both anterior and posterior margins bear low rounded rim. Surface of the carapace ornamented with reticulate pattern of rounded ridges separating elongate, rounded pits.

Dimensions of the plesiotype no. 2478, a complete carapace from locality 43: Length 0.557 mm; height 0.405 mm.

This species was originally reported from beds of Chipola to Choctawhatchee in age. It also occurs at the *Arca* zone localities 24, 26, 27, 28, 29, and 30; *Ecphora* zone localities 37, 38, 39, 40, 42, 43, 44, 47, and *Cancellaria* zone localities 48, 49, 50, 53, 54, 55, 57, and 58.

Hemicythere confragosa Edwards
Pl. 1, Figs. 4–6

Hemicythere confragosa Edwards, 1944, p. 518, pl. 86, figs. 23–26.

This species resembles *H. conradi* but could easily be distinguished from it by its much stronger ornamentation. It was originally described from the Duplin marl of North Carolina but also occurs at Florida localities 39, 41, 42, and 47.

Dimensions of plesiotype no. 2470, a complete specimen: Length 0.540 mm; height 0.338 mm; plesiotype no. 2471, a complete carapace: Length 0.608 mm; height 0.371 mm; plesiotype no. 2472, a left valve: Length 0.591 mm; height 0.354 mm. The figured specimens came from *Ecphora* zone localities 42 and 43.

Hemicythere amygdala Stephenson
Pl. 1, Fig. 3

Hemicythere amygdala Stephenson, 1944, p. 158, pl. 28, figs. 8, 9.

This species is very similar to *H. conradi* from which it differs in its more ovate form in side view, more closely spaced pitting pattern and more obscure cardinal angles. This species was originally described from the *Marginulina-Heterostegina-Discorbis* zones of Texas.

Dimensions of the plesiotype no. 2469, a complete specimen from locality 1: Length 0.591 mm; height 0.371 mm. This species also occurs at the Chipola localities 2, 3, 4, 5, 6, 7, 11, and 13; Oak Grove localities 15 and 16; and Shoal River locality 17.

Hemicythere howei Puri, n. sp.
Pl. 1, Figs. 7–9

Carapace small, thickest near the middle, in side view subovate. Dorsal margin straight, ventral margin slightly convex near the middle. Anterior end broadly rounded, posterior end sharply triangular. Surface of the carapace finely reticulate. There is a thickened marginal rim present which is generally more pronounced at the ventral margin. Hinge normal for the genus.

Dimensions of holotype no. 2473, a complete carapace: Length 0.507 mm; height 0.304 mm; paratype no. 2474, a complete carapace: Length 0.490 mm; height 0.304 mm. The figured specimens came from the *Arca* zone locality 27 and *Ecphora* zone locality 43.

This species is close to *H. conradi*, but it can easily be distinguished from it by its marginal thickened rim, finely reticulate ornamentation, and angular shape.

Genus **Caudites** Coryell and Fields

Caudites Coryell and Fields, 1937, p. 10; Van den Bold, 1946, p. 31.

Genotype: Caudites medialis Coryell and Fields, 1937, p. 11. Miocene, Gatun formation, Panama.

Carapace small, thick-shelled, elongate, subtriangular. The anterior with a thickened rim and with additional longitudinal and dorsal ridges. Surface largely smooth. Anterior end broadly rounded; posterior rather drawn out. The valves decidedly compressed. Hinge similar to *Hemicythere*.

Range: Eocene to Recent.

Caudites sellardsi (Howe and Neill)
Pl. 2, Fig. 6

Hemicythere sellardsi Howe and Neill, in Howe *et al.*, 1935, pp. 29, 30, pl. 2, figs. 6, 10.

This species was based on a single complete carapace from the Choctawhatchee locality 34. It is an excellent marker of the *Arca* zone and has also been found at localities 23, 24, 25, 28, and 30.

Dimensions of the plesiotype no. 2482, a complete carapace from locality 24: Length 0.557 mm; height 0.287 mm.

Caudites chipolensis Puri, n. sp.

Pl. 2, Figs. 7, 8

Carapace small, compressed subtriangular in outline. Anterior end broadly rounded, posterior end much narrower; dorsal and ventral margins sinuous and converging towards the posterior. Three prominent transverse raised ribs emerge at the posterior rostrum and continue for three-fourths of the distance toward the anterior end before they merge with the anterior slope. There is usually a thickened rim around the margins. A number of short, transverse ribs produce subreticulate effect.

Dimension of holotype no. 2483, a left valve: Length 0.591 mm; height 0.287 mm; paratype no. 2484, a right valve: Length 0.625 mm; height 0.304 mm. Both the figured specimens came from Chipola locality 6. It also occurs at Chipola localities 4 and 12 and is an excellent marker for the Chipola formation.

C. chipolensis resembles *C. sellardsi* but could easily be identified from it by three transverse ribs, more pronounced subreticulate pattern of ornamentation, and slightly larger carapace.

Genus **Procythereis** Skosberg

Cythereis (*Procythereis*) Skosberg, 1928, p. 17.

Genotype (by original designation): *Cythereis* (*Procythereis*) *torquata* Skosberg, 1928, p. 19. Recent, Tierra del Fuego.

Shell a *Hemicythere* with a nearly straight dorsal margin which nearly parallels the sinuous ventral margin. Anterior end obliquely rounded; posterior angular below and above, truncated just below middle. Surface pitted to almost reticulate, with a strong alate ridge near the ventral margin which bears a row of oblique excavations on its upper side. Hinge similar to *Hemicythere*.

On the basis of soft parts, Skosberg subdivided *Procythereis* into two groups: *Torquata* and *Radiata*.

Range: Miocene to Recent.

Procythereis calhounensis (Smith)

Pl. 2, Figs. 9–11

Hemicythere calhounensis Smith, 1941, pp. 280, 281, pl. 1, fig. 7; pl. 2, fig. 11.

Carapace subquadrate, stout, and fat. Inflated ventrally with an ala. Dorsal margin slightly convex, ventral margin slightly sinuous; both margins converging posteriorly. Anterior end broadly rounded, somewhat produced ventrally, posterior narrow. Surface of the carapace reticulate, the pits being arranged in a linear series in curved rows. Hinge similar to *Hemicythere*.

Dimensions of plesiotype no. 2485, a left valve: Length 0.695 mm; height 0.371 mm; plesiotype no. 2486, a right valve: Length 0.608 mm; height 0.371 mm; plesiotype no. 2487, a right valve: Length 0.608 mm; height 0.354 mm. All figured specimens came from Chipola locality 1.

This species was originally described from the Chipola locality 12. It is an excellent Chipola marker and occurs at localities 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, and 13.

BIBLIOGRAPHY

BAIRD, WILLIAM. *The natural history of the British Entomostraca.* Ray Soc., London **18:** i–viii, 1–364, pls. 1–36 (Ostracoda, pp. 138–182, pls. 18–23). 1850.

BLAKE, C. H. *Ostracoda*, in Biological Survey of Mount Desert Region. Pt. **5:** 229–241, fig. 40. 1933.

BRADY, G. S. *On new or imperfectly known species of marine Ostracoda* (1865). Trans. Zool. Soc. London **5:** 359–393, pls. 57–62. 1866.

———. *A monograph of the Recent British Ostracoda.* Trans. Linnean Soc. London **26:** 353–495, pls. 23–41. 1868.

———. *Marine Ostracoda from the Mauritius.* Ann. Mag. Nat. Hist. (4) **2:** 220–225, pls. 14, 15. 1868.

———. *Ostracoda from the Arctic and Scandinavian seas.* Ann. Mag. Nat. Hist. (4) **2:** 30–35, pls. 4, 5. 1868.

———. *Les fonds de la mer* **1:** 54–163, pls. 4–19. 1869.

———. *Report on the scientific results of the voyage of H. M. S. Challenger during the years 1873–1876*, Zoology **1** (3): *Ostracoda*, 184 pp., 44 pls. 1880.

———. *On new or imperfectly-known Ostracoda, chiefly from New Zealand.* Trans. Zool. Soc. London **14:** 429–452, pls. 43–47 . 1898.

———. *On new or imperfectly known Ostracoda, chiefly from a collection in the Zoological Museum, Copenhagen.* Trans. Zool. Soc. London **16** (4): 179–210, pls. 21–25. 1902.

CORYELL, H. N., and FIELDS, SUZANNE. *A Gatun ostracode fauna from Cativa, Panama.* Amer. Mus. Nov. 956: 18 pp., 2 pls. 1937.

CUSHMAN, J. A. *Marine Ostracoda of Vineyard Sound and adjacent waters.* Proc. Boston Soc. Nat. Hist. **32** (10): 359–385, pls. 27–38. 1906.

EDWARDS, RICHARD A. *Ostracoda from the Duplin marl (upper Miocene) of North Carolina.* Journ. Pal. **18** (6): 505–528, pls. 85–88. 1944.

ELOFSON, OLOF. *Zur Kenntnis der marinen Ostracoden Schwedens mit besonderer Berücksichtigung des Skageraks.* Zool. Bidrag. **19:** 217–518, 42 figs. 1941.

HOWE, H. V. *New Tertiary ostracode fauna from Levy County, Florida.* Florida Geol. Surv. Bull. 34, pt. 1: 1–32, 5 pls. 1951.

Howe, H. V., and Chambers, Jack. *Louisiana Jackson Eocene Ostracoda.* Louisiana Geol. Surv. Bull. 5: 1–65, 6 pls. 1935.

Howe, H. V., et al. *Ostracoda of the* Arca *zone of the Choctawhatchee Miocene of Florida.* Florida Geol. Surv. Bull. 13: 1–37, 4 pls. 1935.

Jones, T. Rupert. *A monograph of the Tertiary Entomostraca of England.* Palaeontogr. Soc. London **9** (2): 68 pp., 6 pls. 1856 [1857].

Klie, W. *Beitrag zur Kenntnis der Ostracoden der sudlichen und westlichen Ostsee, der festlandischen Nordseekueste und der Insel Helgoland.* Zeitschr. Wiss. Zool. Leipzig **134:** 270–306. 1929.

LeRoy, L. W. *Pleistocene and Pliocene Ostracoda of the coastal region of southern California.* Journ. Pal. **17:** 354–373, pls. 58–62. 1943.

Lienenklaus, E. *Die Ostracoden des mitteleren Nord-deutschlands.* Deutsch. geol. Ges. **52:** 497–550, pl. 19–22, 10 figs. 1900.

Müller, G. W. *Fauna und Flora des Golfes von Neapal.* Zool. Station Naples Mon. **21:** viii–404, 40 pls. 1894.

Namias, I. *Ostracodi fossili della Farnesina e M. Mario.* Paleontologr. Italica **6:** 83–112, pls. 14–15. 1900.

Neviani, A. *Ostracodi fossili d' Italia. I, Vallebiaja (Calabriano).* Mem. Pont. Acc. Nuovi Lincei ser. 2, **11:** 1–118, pls. 1–2. 1928.

RANGE OF HEMICYTHERE IN AMERICA

SPECIES OF HEMICYTHERE	FORMATIONS												
	Eocene		Oligocene		Miocene								Recent
	Avon Park limestone	West Indies	Mariana	*Marginulina-Heterostegina-Discorbis z.*	West Indies	Chipola	Oak Grove	Shoal River	*Yoldia* zone	*Arca* zone	Calvert	Duplin	North Atlantic
arenicola													XXX
concinna													XXX
crenulata													XXX
strandentia													XXX
truitti													XXX
confragosa												XXX	
laevicula												XXX	
minuta												XXX	
howei										XXX		XXX	
punctistriata											XXX		
conradi						XXX	XXX	XXX	XXX	XXX		XXX	
antillea					XXX								
amygdala				XXX									
saginata				XXX									
kniffeni			XXX										
limbata		XXX											
symmetrica		XXX											
aleatoria	XXX												
bellula	XXX												
cribraria	XXX												
lemniscata	XXX												
lienosa	XXX												
phrygionia	XXX												
mota	XXX												

RANGE OF CAUDITES IN AMERICA

(Species listed under the generic name under which they were originally described)

SPECIES	FORMATIONS					
	Lower Eocene, Guatemala	Chipola Miocene, Florida	*Arca* zone Miocene, Florida	Gatun Miocene, Panama	Pleistocene, Southern California	Recent, Panama
Cythere rectangularis Brady, 1869, p. 153						XXX
Caudites fragilis LeRoy, 1943, p. 372					XXX	
Caudites medialis Coryell and Fields, 1937, p. 11				XXX		
Hemicythere sellardsi Howe and Neill, in Howe *et al.*, 1935, p. 29			XXX			
Caudites chipolensis Puri, n. sp.		XXX				
Caudites nipeensis Van den Bold, 1946, p. 103	XXX					

NORMAN, A. M. *On species of Ostracoda new to Great Britain.* Ann. Mag. Nat. Hist. (3) **9:** 43–47. 1862.

SARS, G. O. *Oversigt af Norges marine Ostracoder.* Forh. Vid. Christiania. 1865: 1–130. 1866.

———. *An account of the Crustacea of Norway: Ostracoda.* **9** (pts. 5–12): 73–208, 64 pls. 1925.

SCHNEIDER, G. *Miocene Ostracoda of the Crimea-Caucasian region.* Problems of Paleontology **5:** Moscow Univ. Publ.: 177–202 (Russian), 203–208 (English summary), 4 pls. 1939.

SEGUENZA, G. *Il quaternario di Rizzolo II: Gli Ostracodi. con I tavola.* Passim ne: Il Naturalista Siciliano, anni II–V. 1882–1886.

SKOGSBERG, TAGE. *Studies on marine Ostracoda, Part II.* Occ. Pap. California Acad. Sci. **15:** 1–154, 6 pls., 23 figs. 1928.

SMITH, R. HENDÉE. *Micropaleontology and stratigraphy of a deep well at Niceville, Okaloosa County, Florida.* Bull. Amer. Assoc. Petr. Geol. **25:** 263–286, 2 pls., 3 figs. 1941.

SPEYER, O. *Die Ostracoden der Casseler Tertiarbildungen.* Cassele, 1863.

STEPHENSON, MORTON B. *New Ostracoda from subsurface Middle Tertiary strata of Texas.* Journ. Pal. **18:** 156–161, pl. 28. 1944.

SYLVESTER-BRADLEY, P. C. *The ostracode genus Cythereis.* Journ. Pal. **22:** 792–797, pl. 122, 1 fig. 1948.

TRESSLER, WILLIS L. *Geology and biology of North Atlantic deep-sea cores between Newfoundland and Ireland, Part 4, Ostracoda.* U. S. Geol. Surv. Prof. Pap. 196-C: i–xviii, 96–104, pl. 19. 1941.

TRESSLER, WILLIS L., and SMITH, ESSIE M. *An ecological study of seasonal distribution of Ostracoda, Solomons Island, Maryland region.* Chesapeake Biol. Lab. Publ. 71: 61 pp., 4 pls. 1948.

TRIEBEL, ERICH. *Die Ostracoden der deutschen Kreide. 3: Cytherideinae und Cytherinae aus der Unteren Kreide.* Senckenbergiana **22:** 160–227, 10 pls. 1940.

———. *Homöomorphe Ostracoden-Gattungen.* Senckenbergiana **31:** 313–330, 4 pls. 1950.

ULRICH, E. O., and BASSLER, R. S. *Systematic paleontology of the Miocene deposits of Maryland, Ostracoda:* 98–130, pls. 35–38. 1904.

VAN DEN BOLD, WILLEM A. *Contribution to the study of Ostracoda with special reference to the Tertiary and Cretaceous microfauna of the Carribbean region:* 167 pp., 18 pls. Amsterdam. 1946.

ZALANYI, BELA. 1913, *Miocäne Ostrakoden aus Ungarn.* Mitt. Jahrb. Ung. Geol. Reichstanst. **21** (4): 85–152, pls. 5–9. 1913.

BOTANY.—*Floral morphology of* Ixophorus unisetus *(Presl) Schlecht.* ERNEST R. SOHNS,[1] U. S. National Museum. (Communicated by Agnes Chase.)

Ixophorus, a monotypic genus in the tribe Paniceae (Gramineae), is placed among those grasses regarded as highly specialized. The spikelets are 2-flowered; the lower floret is staminate and the upper floret is perfect (but the rudimentary stamens of this floret are nonfunctional). This grass is related to *Setaria*, *Setariopsis*, *Chamaeraphis*, *Paratheria*, *Pennisetum*, the section *Paurochaetium* of *Panicum* and other genera having their spikelets surrounded and/or subtended by sterile branches. The spikelet (or spikelets), with surrounding or subtending bristle (or bristles), constitutes the fascicle.

The taxonomic position of this grass has been in doubt. The genus has been confused with other panicoid genera. The purpose of this paper is to clarify the morphology of the fascicle of this interesting species.

Historical.—The species was first described by J. S. Presl (1830) as *Urochloa uniseta*, based on a specimen collected by Thaddaeus Haenke in Mexico. Schlechtendal (1861–1862), apparently having access only to Presl's description and to a drawing of a species of *Urochloa* from the Isle de France (*pl. 11, f. 1*, in the Atlas of Beauvois, Ess. Agrost. 1812) established the genus *Ixophorus*. He was not certain whether to assign the plant to a genus or to a section of *Panicum*, viz., ". . .so bilde ich aus diesen Pflanzen eine eigene Abtheilung, welche man Gattung oder *Panicum*-Section nach Belieben nennen mag, und bezeichne sie mit einem eigenen Namen: *Ixophorus*." Nevertheless, Schlechtendal properly described the genus (p. 420–421) and the combination was made in the index (p. 747). The resemblance of this species to *Panicum* led Trinius (1834) to transfer Presl's species to *Panicum*. Fournier (1886) transferred the species to *Setaria*. Vasey (1893), in naming grasses collected by Palmer in Sonora and Colima, Mexico, described Presl's species under *Panicum* (*P. pringlei*). *Setaria* is a name which was first applied to a genus of lichens by Acharius and later to a genus of grasses by Beauvois (Hitchcock, 1925). Beauvois' name has been conserved, but the homonym caused

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[1] Part of a thesis, "The Floral Morphology of *Cenchrus, Pennisetum, Setaria* and *Ixophorus*," submitted to the faculty of the Graduate School of Indiana University in partial fulfillment of the requirements for the degree doctor of philosophy. The writer is grateful to Dr. Paul Weatherwax for suggesting the problem and for helpful suggestions throughout the investigation.

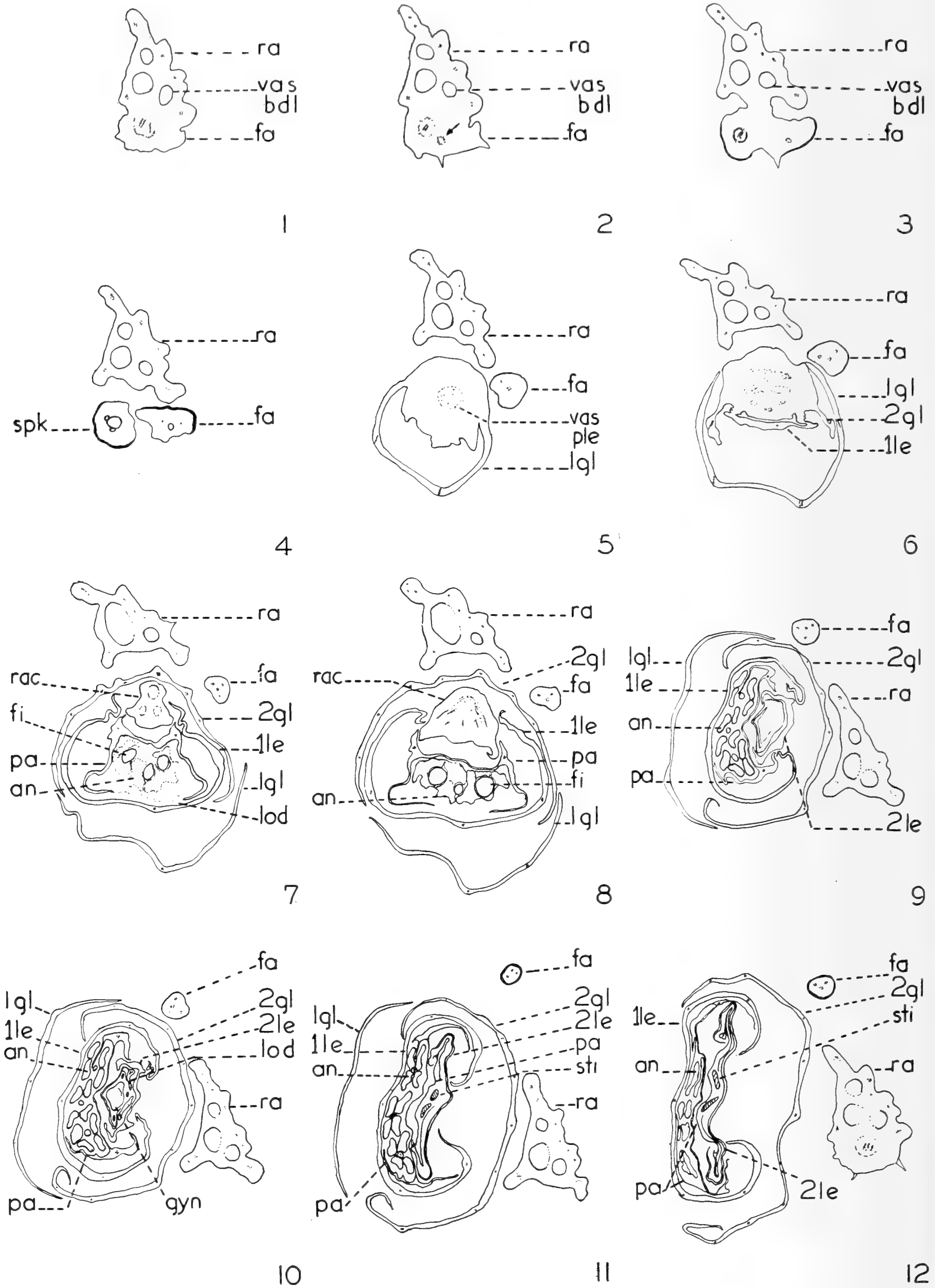

FIG. 1–12.—Diagrammatic transsections of the rachis and fascicle of *Ixophorus unisetus*. an—anther; fa—fascicle; fi—filament; 1 gl—first glume; 2 gl—second glume; gyn—gynoecium; 1 le—lemma of the lower floret; 2 le—lemma of the upper floret; lod—lodicule; pa—palea; ra—rachis; rac—rachilla; spk—spikelet; sti—stigma; vas bdl—vascular bundle; vas ple—vascular plexus. All figures approximately × 25.

much trouble before it was included in Nomina Generica Conservanda. Nash (1895), seeking a valid name for *Setaria*, concluded that *Ixophorus* was the earliest valid name and transferred the species of *Setaria* to *Ixophorus*. Beal (1896) misapplied the name of the Australian genus, *Chamaeraphis*, to *Setaria* and *Ixophorus*. See Pilger (1928) for a history and discussion of the genus *Chamaeraphis*. Hitchcock (1936) stated that *Chamaeraphis* is "an Old World genus in which the articulation is below the spikelet-bearing branches, as in Pennisetum." F. Lamson-Scribner (1897) used the generic name *Ixophorus* and proposed a new species and a variety (both since relegated to synonomy under *I. unisetus*). The history of the genus and its synonomy was published by Hitchcock (1919).

Distribution and economic importance.—*Ixophorus unisetus* was first found in Mexico (Hitchcock, 1919). Its present distribution, based on specimens in the U. S. National Herbarium, includes Mexico, El Salvador, Guatemala, Honduras, Nicaragua, and Costa Rica; Cuba; Colombia, Venezuela, and Brazil. The grass is cultivated in all these countries and has been grown in Experiment Stations in the United States and Hawaii. It is reported to be a good, palatable, annual forage grass. This species is known under a dozen or more vernacular names, e. g., Copo sojo, Honduras grass, Mesmete, Molino grass, Pasto Atico, Pasto blanco, Pindiniqua, Pitillo, Zacate blanco, Zacate dulce, Zacate conejo, Zacate de Honduras and Tonciro.

Material and method.—Material was collected at Quirigua, Guatemala, and provided by Dr. Paul Weatherwax. Fascicles were processed according to standard methods in microtechnique. All drawings were made with the aid of a camera lucida. Figs. 1–12 are diagrammatic drawings made from serial sections of a portion of an inflorescence.

Observations.—A diagrammatic transsection of the rachis (*ra*) is shown in Fig. 1. The vascular supply of the fascicle (*fa*) is indicated by the dotted area in the lower left of the figure, while the irregular circular areas represent vascular bundles (*vas bdl*) of the rachis. A transsection of the rachis shows a well-defined, cutinized epidermis and a central parenchyma area having small vascular bundles near the periphery and two to four larger, centrally located, vascular bundles. In fig. 2 the vascular mass of the fascicle is divided into two unequal areas, the smaller of which (indicated by an arrow) is the vascular supply of the bristle and the larger is the vascular supply of the spikelet. Fig. 3 shows the relationship of the fascicle axis (*fa*) to the rachis (*ra*). The relationship of the fascicle axis (*fa*), spikelet (*spk*) and rachis (*ra*) is shown in Fig. 4. At the level of Fig. 5, the first glume (*1 gl*) is shown. The stippled area in the base of the spikelet represents the main vascular plexus (*vas ple*) of the spikelet. In Fig. 6, the first glume (*1 gl*), the second glume (*2 gl*), and the lemma of the lower floret (*1 le*) are shown. The organization of the lower floret is diagrammed in Fig. 7. The palea (*pa*) is strongly 2-keeled and each keel has a pronounced wing at maturity. The pistil does not develop and its vascular trace terminates blindly. The bases of the filaments (*fi*) are multicellular and thick. The three anthers (*an*) are indicated by outline. The lower floret has two lodicules (*lod*), which are large and well-developed, and the position of each is indicated by a dotted outline. The rachilla segment (*rac*) below the upper floret is shown at two successively higher levels in Figs. 7 and 8. The organization of the fascicle above the level shown in Fig. 8 could not be followed because shattering ruined subsequent serial sec-

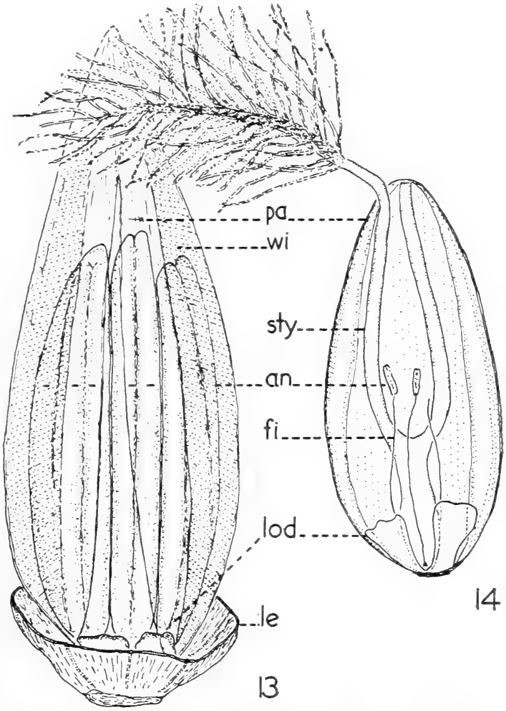

FIG. 13.—Lower floret of spikelet of *Ixophorus unisetus*. FIG. 14.—Upper floret of same spikelet. an—anther; fi—filament; le—lemma; lod—lodicule; pa—palea; sty—style; wi—wing. Both figures approximately × 7.

tions. Another portion of the same inflorescence was selected to show the organization of the upper floret. The first of these diagrams is that of Fig. 9 showing the lemma (*2 le*). In Fig. 10, the upper floret is shown with two lodicules (*lod*), three filaments (*fi*) [shown as black dots], and a gynoecium (*gyn*). The palea (*pa*) of the upper floret is keeled, but the keels are not as prominent as those of the palea of the lower floret. At the levels in Figs. 11 and 12, the anthers (*an*) of the lower floret, and the stigmas (*sti*) of the upper floret are shown.

Examination of the material in the U. S. National Herbarium revealed no lower florets (Fig. 13) with pistils, but an upper floret (Fig. 14) occasionally has nonfunctional stamens. The anthers of the upper floret are small, empty, sac-like structures. In Fig. 14, one anther is missing as well as one branch of the stigma.

F. Lamson-Scribner (1897) used the character of smooth bristles as one criterion for separating *Ixophorus* from *Panicum.* Forty-one percent of the material in the U. S. National Herbarium has antrorsely scabrous bristles. These bristles vary from scabrous at the base to half their length. The remainder (59 percent) of the material has viscid, smooth bristles. Smooth bristles have a heavy cuticle. The axis of the inflorescence varies from scabrous to pilose-pubescent. The individual plants range from 10 cm to 1 meter in height. These characters, whether taken separately or collectively, are of insufficient magnitude to warrant segregation of another species or a variety in this genus.

Discussion.—The fascicle of *Ixophorus unisetus* consists of a 2-flowered spikelet with a single bristle prolonged behind it. The bristle is interpreted as a continuation of the axis of the fascicle. The spikelet has two distinctly different florets. The lower is larger, membranous, staminate and the upper is smaller, indurated, and functionally pistillate. In addition, each floret has two well-developed lodicules. The paleas of both florets are winged at maturity. The very small nonfunctional stamens of the upper floret, the presence of lodicules in both florets, and the wings on the paleas are types of specialization not common to most panicoid grasses.

Summary.—The taxonomic history and the morphology of the fascicle of the monotypic genus *Ixophorus* are presented in this paper. A morphological study of the fascicle indicates that this genus is separate and distinct in the *Paniceae* and has specializations not common to most panicoid grasses.

LITERATURE CITED

Beal, W. J. *Grasses of North America* **2:** 150–159. New York, 1896.

Fournier, E. *Mexicanas plantas*; pt. 2: 43. Ex Typographeo Republicae, Parisiis, 1886.

Hitchcock, A. S. *History of the Mexican grass, Isophorus unisetus.* Journ. Washington Acad. Sci. **9:** 546–551. 1919.

———. *Descriptive systematic botany*: 125. New York, 1925.

———. *The genera of grasses of the United States, with special reference to the economic species.* (Revised by Agnes Chase). U. S. Dept. Agr. Techn. Bull. 772: 251. 1936.

Presl, J. S. *Reliquiae Haenkeanae*: 319. Prag, 1830.

Lamson-Scribner, F. *Studies on American grasses. I. The genus* Ixophorus. U. S. Dept. Agr. Div. Agrost. Bull. 4: 5–7, pls. 1–2. 1897.

Nash, G. V. *New or noteworthy American grasses.*—I. Bull. Torrey Bot. Club **22:** 419–424. 1895.

Pilger, R. *Ueber* Chamaeraphis *R.Br.* Notizbl. Bot. Gart. Berlin-Dahlem **10:** 207–210. 1928.

Schlechtendal, D. F. L. von. *Ueber* Setaria *P. B.* Linnaea **31:** 420–421, 747. 1861–1862.

Sohns, E. R. *Floral morphology of* Cenchrus, Pennisetum, Setaria *and* Ixophorus. Thesis (Ph.D.), Indiana University, 1949.

Trinius, C. B. *Panicearum Genera.* Mém. Acad. St. Pétersbourg VI. Sci. Nat. **1:** 217. 1834.

Vasey, George. *Gramineae. In* J. N. Rose's "Report on a Collection of Plants Made in the States of Sonora and Colima, Mexico, by Edward Palmer, in the years 1890–1891." Contr. U. S. Nat. Herb. **1:** 363. 1895.

ENTOMOLOGY.—*A new species of* Climacia *from California* (*Sisyridae, Neuroptera*). Harry P. Chandler, California Department of Fish and Game, Red Bluff Calif. (Communicated by Ashley B. Gurney.)

The Sisyridae are small Neuroptera which are parasites in their larval stage on fresh-water sponges. Though widely distributed in North America, especially in the eastern half of the United States, they are frequently localized and are poorly known even to most entomologists. The species here described constitutes the only record of the family Sisyridae from California that is known to the author, and this is the first time the genus *Climacia* has been recorded west of the Rocky Mountains.

Climacia californica, n. sp.

Holotype (male): Head, antennae, and palpi dark brown with margins of face paler; thorax dark brown with medial portion paler; legs light yellow; abdomen dark brown. Ultimate segment of maxillary palpi (Fig. 1, A) slightly swollen, widest near middle, outer side straight, inner side uniformly tapering to lanceolate point. Forewing; length 4 mm, width 1.3 mm, membrane clear with brown markings, much as in *C. areolaris* but less intense; wing bristles more pronounced; a brown patch extending from base of wing between Sc and MA to proximal third of wing, then faintly to posterior margin and back through anal region to base of wing; another triangular patch extending from two costal veinlets on each side of base of pterostigma to about middle of wing; pterostigma hyaline; tip of wing with light brown colored area extending from outer fourth of pterostigma which is darker, in an oblique concave arc to posterior margin at basal two-fifths, the posterior marginal area faintly broken into two spots by pale areas near end of Cul and MP2. Cell R1 between second and third cross vein not more than twice as long as wide, third cross vein proximal to junction of R1 with pterostigma; second cross vein between R4-5 and MA distal to fork in MA; third apparent cross vein between MA and MP1-2 proximal to forking of the latter; MP1-2 with third fork vein originating nearer fourth than second. Hindwings; length 3.5 mm, width 1.2 mm; color pattern about as in front wings but much fainter except in area of pterostigma. Abdomen; (Fig. 1, D), tenth tergite forming a band of nearly uniform width which, when viewed posteriorly, resembles an inverted V with apex slightly rounded, narrowly divided dorsally, lower margins slightly produced posteroventrally; tenth sternite joined at a sharp angle to inner edge of posterior margin of tenth tergite, the upper third at right angles to tergite, twisting anteriorly below so that lower third, which is about twice as wide, joins the tergite at a 45° angle; covered with coarse papillae, each bearing a bristle; ninth sternite without projecting processes.

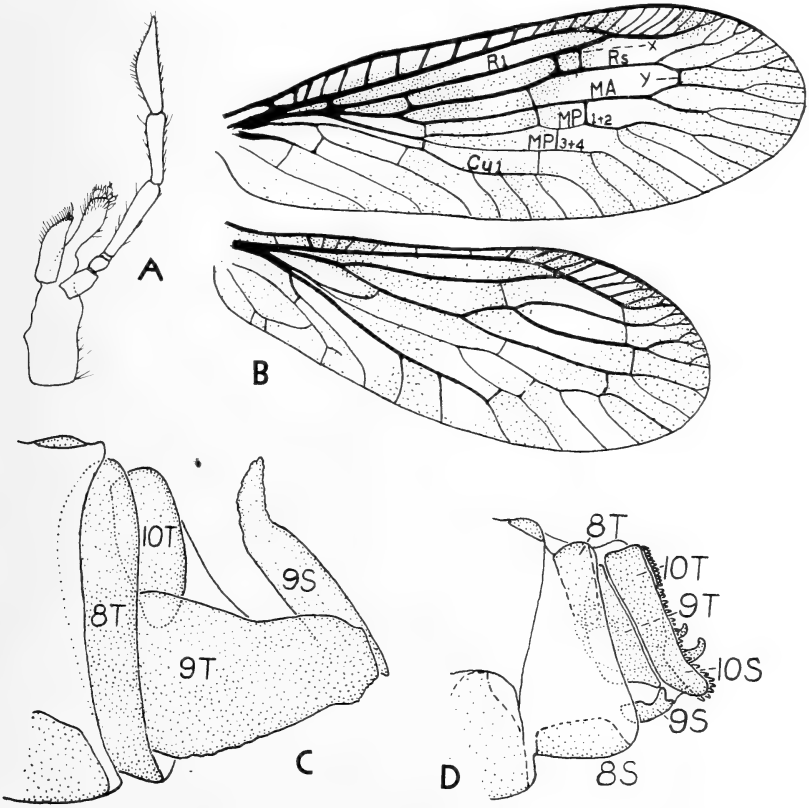

FIG. 1.—*Climacia california*, n. sp.: A, maxillae; B, wings; C, female genitalia; D, male genitalia.

Allotype (female): Forewing 5.2 by 1.7 mm; hind wing 4.5 by 1.7 mm. Genitalia (Fig. 1, C), ninth tergite with dorsal margin depressed to middle; ninth sternite parallel sided to upper third, than narrowed and bent posteriorly; tenth tergite horseshoe-shaped, posterior margin rounded and covered with bristles so that in lateral view it looks like a bristly pad.

Holotype (male): Clear Lake, Lake County, Calif., May 19, 1949, elevation 1,318 feet, H. P. Chandler. Allotype, same collection data. Paratypes, same collection data, 27 mounted specimens (16 males and 11 females) plus several in alcohol. Holotype, allotype, and three paratypes will be placed in the collection of the California Academy of Sciences, and two paratypes each in the U. S. National Museum, the Museum of Comparative Zoology, the Harley P. Brown collection, and the collection of the California Insect Survey.

The males are smaller than the females, head and body often with more yellow, the wings tend to be less densely colored and with colored area more restricted as in typical *C. areolaris*. This species may be separated from *C. areolaris* as redescribed and figured by Carpenter (pp. 255–256) and as figured by Brown (pp. 152–153) by the location of the cross veins mentioned in the description above, especially the third cross vein in cell R, and the third in cell MA (fig. 1, B, *x*, *y*); the parallel-sided ninth sternite; and the absence of a notch on the dorsal margin of the ninth tergite in the female; the sharp edged and concave posterior face of the male genitalia formed by the tenth sternites. The first branch of MP1-2 is never angular at its base, resembling a cross vein. The eyes are noticeably smaller and the antennae less robust than in the specimen figured by Brown. The number of branches of Cu reaching the margin was variable; 80 percent of the males had four and 82 percent of the females had five; none had more than five, and two males had only three.

The third instar larva resembles the larva figured by Brown (p. 146). The following exceptions are noted: The antennae have 14 segments instead of 16, the third of which is three times as long as any other segment instead of two times. The posterior bristles on the abdomen extend the width of four segments past the tip of the abdomen instead of being about even with the tip. The "neck" area is more pronounced and the pronotum more elongate.

The existence of this species was first suspected by the author while sorting Trichoptera in the California Academy of Sciences. A specimen damaged by dermestids with only the thorax and wings remaining was found among the Trichoptera. It had been taken in a light trap at Clear Lake. Several trips were made to Clear Lake to find more specimens during 1946 and 1947. A number of larvae were taken on fresh-water sponges at Rocky Point, but no adults were ever taken. In 1949 between May 16 and 19 the author made a survey of the insect fauna of this lake for the California Department of Fish and Game for the purpose of learning something about the existing fauna before this 43,000 acre lake was treated with TDE under the direction of the U. S. Bureau of Entomology and Plant Quarantine to eliminate the Clear Lake gnat (*Chaoborus astictopus* D. & S.). On the fourth and last day of this survey a determined effort was made to locate adults of this species. The site selected was near Jago's resort at the south end of the lake where the waves from the prevailing wind beat against the boulders on a rocky point. The author rowed across Jago Bay to the point. The first swing of the net in the bushes above the rocks produced an adult specimen. Pupae and parasites were taken in protected areas on the rocks above water and larvae from sponges on the rocks below the water surface. The author has not visited this site since the lake was treated with TDE, but larvae have been taken from sponges at Rocky Point since then. Apparently the species was not destroyed.

REFERENCES CITED

Brown, Harley P. *The life history of* Climacia areolaris *(Hagen), a neuropterous parasite of fresh water sponges*. Amer. Midl. Nat. **47** (1): 130–160, 16 figs. 1952.

Carpenter, F. M. *A revision of the Nearctic Hemerobiidae, Berothidae, Sisyridae, Polystoechotidae, and Dilaridae*. Proc. Amer. Acad. Arts and Sci. **74** (7): 193–280, 75 figs., 3 pls. 1940.

ENTOMOLOGY.—*The ant larvae of the myrmicine tribes Melissotarsini, Metaponini, Myrmicariini, and Cardiocondylini.*[1] George C. Wheeler and Jeanette Wheeler, University of North Dakota. (Communicated by C. F. W. Muesebeck.)

The four small tribes treated herein have little in common except that they are all in the formicid subfamily Myrmicinae; that they are all aberrant and highly specialized; and that their affinities are most obscure.

Tribe Melissotarsini Emery

This highly aberrant tribe comprises only six species in two genera—*Melissotarsus* from Africa and Madagascar and the Indomalayan *Rhopalomastix.* Emery (1921/22, p. 8) regarded them as very primitive but very profoundly adapted to particular conditions of existence. According to Wheeler (1929, Psyche **36**: 100) they are probably the last survivors of some very ancient myrmicine stock.

We find the larva of *Rhopalomastix* to be quite aberrant among the Myrmicinae but not notably specialized.

Genus **Rhopalomastix** Forel

Moderately slender. Diameter nearly uniform throughout, slightly constricted between the first and second abdominal somites. Slightly curved ventrally; dorsal profile evenly convex; ventral profile angulate between the first and second abdominal somites, otherwise nearly straight. Anterior end broadly rounded. Posterior end with a conspicuous dorsal knob projecting posteriorly. Spiracles minute and uniform. Head protruding from the ventral surface near the anterior end. Body hairs of three types: (1) Generally distributed, short, slightly curved, with short-branched tip; (2) very long, flexible, with short-bifid tip, restricted to the lateral surfaces, most numerous on prothorax, diminishing posteriorly; (3) a few minute simple spikes on the ninth and tenth abdominal somites. Cranium quadrate, with the corners rounded; front bulging enormously. Antennae with two sensilla each. Anterior surface of labrum with 10—12 hairs which are as large as those on the head; posterior surface with only a few spinules. Mandibles feebly sclerotized, except the teeth which are heavily sclerotized; proximal medial tooth very stout; no spinules. Maxillae with the apex short-subconical and directed medially; palp a small low elevation bearing three sensilla; galea consisting of two small contiguous cones, each bearing an apical sensillum. Labium small and hairy. No spinules on the hypopharynx.

Rhopalomastix rothneyi Forel
Figs. 13–20

Moderately slender. Diameter nearly uniform throughout, greatest at the fifth abdominal somite, slightly constricted between the first and second abdominal somites. Slightly curved ventrally; dorsal profile evenly convex; ventral profile angulate between the first and second abdominal somites, otherwise nearly straight. Anterior end broadly rounded. Posterior end with a conspicuous dorsal knob projecting posteriorly; anus posterior, immediately beneath the knob. Ventral surface slightly flattened (but still convex), bordered on each side by a lateral longitudinal welt. Head protruding from the ventral surface near the anterior end. Anterior end formed from the dorsal surface of the prothorax. Leg vestiges present. Spiracles minute. Body hairs moderately numerous. Of three types: (1) Generally distributed, short (0.036–0.072 mm), slightly curved, with a short-branched tip; (2) very long (0.14–0.31 mm), flexible, with short-bifid tip, restricted to the lateral surfaces, most numerous on the prothorax, diminishing posteriorly; (3) a few minute (0.001–0.002 mm) simple spikes on the ninth and tenth abdominal somites. Integument of ventral surface of thorax sparsely spinulose, the spinules rather coarse and usually isolated. Cranium quadrate, a trifle broader than long, the corners rounded; front bulging enormously. Head hairs rather numerous, short (0.018–0.036 mm), stout, with frayed tip. Antennae each with two sensilla, each of which bears a spinule. Labrum small, short, subrectangular, slightly narrowed ventrally; anterior surface with 10–12 hairs which are similar to and as large as head hairs; ventral border with six sensilla and a few isolated spinules; posterior surface with a few spinules and sensilla near the ventral border. Mandibles rather stout; teeth heavily sclerotized, otherwise feebly sclerotized; apex curved medially and forming a slender sharp-pointed tooth; first medial tooth similar to apical, proximal very

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[1] The research on which this article is based was aided by a grant-in-aid from the Sigma Xi-Resa Research Fund.

stout; all teeth near the anterior surface and all pointed medially. Maxillae swollen; apex short-subconical and directed medially; spinulose, the spinules minute, stout and isolated; palp a small low elevation with three sensilla, two of which bear each a spinule, the third a conical cap; galea consisting of two small contiguous cones, each bearing an apical sensillum with its spinule. Labium small and hairy; palp small, with three spinule-bearing sensilla, two of which are mounted on subcones; opening of sericteries a very short transverse slit dorsal to the palps. (Material studied: 20 larvae from Singapore.)

Tribe METAPONINI Forel

Genus **Metapone** Forel

When Forel established this genus in 1911 he placed it provisionally in the Ponerinae in a special section which he called Promyrmicinae. "A year later, Emery examined *M. greeni* and its larva more critically and found that alcoholic specimens of the latter when properly softened and expanded had the usual shape of body, head and mouthparts of the Myrmicine larva and were furnished with long, serially arranged, hooked, dorsal hairs unlike any known Ponerine larvae, but like many larval Myrmicinae" (Wheeler, 1919, p. 173). Emery concluded that *Metapone* was a true myrmicine but retained the section Promyrmicinae to include the tribes Metaponini and Pseudomyrmicini. In the *Genera insectorum* (1921/22) he placed it at the beginning of the Myrmicinae. In 1919 (p. 177) Wheeler was convinced that *Metapone* was an "aberrant and highly specialized, though probably ancient genus of Myrmicinae, neither primitive nor ancestral," and placed the tribe "provisionally between Emery's Melissotarsini and his Stereomyrmicini." It is most unfortunate, therefore, that we have no larvae of this genus for study. The published figures and descriptions are inadequate, controversial and inconclusive.

Metapone greeni Forel

Forel (1911, p. 446) in the definition of his new section Promyrmicinae characterized the larvae as "extrêmement sveltes, distinctement articulées, sans tubercules, mais pourvues de longues soies, avec une tête distincte et deux long crocs chitineux ont tout à fait le facies des Ponérines." (Quoted by Emery, 1912, p. 94.) Fig. 7 showed a larva in side view.

Emery, 1912, p. 94:

Je donne ici une esquisse d'une jeune larve de *Metapone* que j'ai fait gonfler dans l'eau distillée, ce qui a fait que la cuticule s'est detachée des muscles, racornis par l'alcool, le contour de la cuticule est passablement différent de la figure de Forel qui, évidemment, a dessiné la larve dans l'alcool, c'est-à-dire ratatinée et maigrie. Dans ma figure, la larve n'est plus extraordinairement allongée et je connais nombre de larves de Myrmicines et de Camponotines qui sont aussi élancées qu'elle. La dite larve a une tête passablement grosse, mais pas plus distincte que d'ordinaire: les crocs qui font saillie dans la figure de la larve contractée par l'alcool, sont grands, mais pas excessivement, dans mon dessin.—J'ai dessiné la tête d'une larve de *Metapone* plus grande (ramollie comme il a été dit plus haut), pour montrer les parties buccales. A mon avis, cette larve n'a guère le facies d'une larve de Ponérine. Dans la larve que j'ai dessinée, les très longues soies sont disposées par rangées transversales, régulières, à la face dorsale de chaque segment et les soies des segments postérieures sont terminées en crochets (poils d'accrochage). C'est un caractère de Myrmicine plutôt que de Ponérine.

Fig. 1, a larva and its head enlarged, both in side view. (See Wheeler below.)

Emery, 1921/22, p. 20: "Larves non hypocéphales."

Wheeler, 1919, p. 173: See above under the genus. Fig. 2 (p. 180) reproduced Emery's (1912) figure.

Tribe MYRMICARIINI Forel

This tribe comprises a single genus of about 15 species. "This extraordinary genus may be recognized at once by the 7-jointed antennae of the worker and female and the unique structure of the abdomen in the male. The species are distributed over the Ethiopian, Indomalayan, and Papuan Regions but do not enter Australia. The majority of the species and the largest are Ethiopian. The large species form crater nests in the soil; some of the smaller, both in Africa and in the Orient, make small carton nests on the under side of leaves" (Wheeler, 1922, Bull. Amer. Mus. Nat. Hist. **45:** 141).

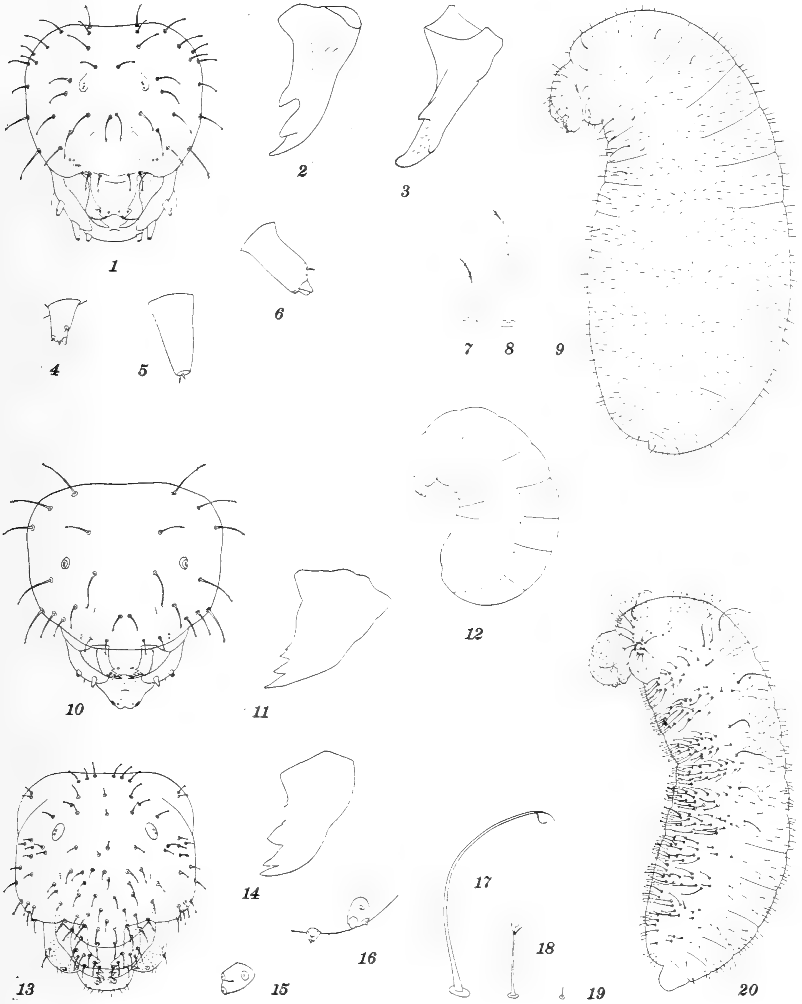
Genus **Myrmicaria** Saunders

Short and very stout; diameter greatest at the third abdominal somite, decreasing gradually toward the anterior end and more rapidly toward the posterior end which is broadly rounded. Thorax strongly arched ventrally; head on the anterior end but directed posteriorly. Dorsal profile long and C-shaped, ventral much shorter.

Spiracles small and uniform. Mouth parts small. Antennae large and drumlin-shaped. No spinules on the posterior surface of the labrum nor on the mandibles or hypopharynx. Mandibles small and short. Labium narrowed ventrally, with two small ventral knobs.

Myrmicaria eumenoides opaciventris Emery
Figs. 10–12

Short and very stout; diameter greatest at the third abdominal somite, decreasing gradually toward the anterior end and more rapidly toward the posterior end, which is broadly rounded. Thorax strongly arched ventrally; head on the anterior end but directed posteriorly. Dorsal profile long and C-shaped, ventral much shorter. Anus postero-ventral. Leg and wing vestiges present. Spiracles small. Integument furnished with minute spinules, isolated or in short rows. Head small; cranium subhexagonal in anterior view, slightly narrowed ventrally, a little broader than long. Mouth parts small. Head hairs few,



FIGS. 1–9.—*Cardiocondyla elegans uljanini* Emery: 1, Head in anterior view, × 95; 2, left mandible in anterior view, × 235; 3, left mandible in medial view, ×235; 4, left labial palp in anterior view, × 340; 5, left galea in anterior view, × 340; 6, left maxillary palp in anterior view, × 340; 7, 8, two types of body hairs, × 235; 9, larva in side view, × 32.

FIGS. 10–12.—*Myrmicaria eumenoides opaciventris* Emery: 10, Head in anterior view, × 56; 11, left mandible in anterior view, × 185; 12, larva in side view (hairs omitted), × 5.

FIGS. 13–20.—*Rhopalomastix rothneyi* Forel: 13, Head in anterior view, × 95; 14, left mandible in anterior view, × 185; 15, labial palp in anterior view, × 371; 16, ventral portion of left maxilla showing palp and galea, × 371; 17–19, three types of body hairs, × 185; 20, larva in side view, × 64.

short to moderately long (0.075–0.15 mm), stout, with denticulate tip. Antennae large, drumlin-shaped; each has three sensilla, each of which bears a spinule. Labrum small; subtrapezoidal in anterior view, narrowed ventrally; ventral border feebly impressed at the middle; anterior surface with 4–8 sensilla; ventral border with four clusters of 3–4 sensilla each; posterior surface with two clusters of three sensilla each and eight isolated sensilla. Mandibles small, short and subtriangular in anterior view, feebly sclerotized except apical teeth which are moderately sclerotized; apex forming a sharp-pointed tooth which is directed medially; two medial teeth shorter and stouter. Maxillae small, with the apex paraboloidal; palp a frustum with three apical and two subapical sensilla; galea a longer frustum with two apical sensilla. Labium narrowed ventrally, with two small ventral knobs; anterior surface spinulose, the spinules minute and in a few short arcuate rows; palp a low elevation bearing five sensilla; opening of sericteries a short transverse slit.

Sexual larva: Longer and much more voluminous; turgid. Head relatively minute. In other respects similar to worker larva.

Material studied: Eight larvae from the Belgian Congo. Since every specimen has had all or most of its body hairs broken off, we have made no attempt to describe these structures.

Myrmicaria exigua Ern. André

Eidmann, 1944, p. 445: "Die Larven sind mit hakenförmigen langen Haaren (*Oncochaeten*) dicht bedeckt, durch welche sie sich leicht zusammenballen oder auch an den Wänden der Kartonnester fest haften."

Tribe CARDIOCONDYLINI Emery

This tribe consists of two genera. *Xenometra* is known only from the female of a single species from the West Indies. *Cardiocondyla* comprises about 20 species occuring throughout tropical and warm temperate regions; the colonies are small; males are generally apterous and ergatoid.

Genus **Cardiocondyla** Emery

Plump, chunky, and subellipsoidal; head ventral near the anterior end, mounted on a stout but very short neck; ends rounded. Spiracles minute, the first slightly larger. Body hairs of one type; with the distal half denticulate. Head hairs with the tip denticulate. Labrum nearly as long as broad. Mandibles with the apex forming a rather long tooth which is curved medially and posteriorly; two stout round-pointed medial teeth (the subapical anterior and the proximal posterior) separated by a denticulate cavity. Maxillae with the apex conoidal and directed ventromedially; palp subcylindrical, with five sensilla. Labial palp a short peg, with five sensilla. No spinules on the hypopharynx.

Cardiocondyla elegans uljanini Emery

Figs. 1–9

Plump, chunky, and subellipsoidal; head ventral, near the anterior end, mounted on a stout but very short neck formed from the anterior portion of the prothorax; anterior end broadly rounded and formed from the dorsa of the prothorax and mesothorax; posterior end rounded. Anus terminal. Leg and wing vestiges present. Spiracles minute, the first slightly larger. Integument with a few short to long transverse rows of minute spinules on the ventral surface of the thorax and anterior abdominal somites and a few on the dorsal surface of the posterior abdominal somites. Body hairs short, numerous and uniformly distributed; with the apical half denticulate; most hairs lack alveolus and articular membrane and range in length from 0.045–0.063 mm; a few, however, are longer (0.054–0.09 mm) and have alveolus and articular membrane. Cranium subhexagonal in anterior view, a little broader than long and slightly narrowed ventrally. Head hairs moderately numerous, rather short (0.036–0.072 mm) with the tip denticulate. Antennae small, with three sensilla each; a minute spinule on each sensillum. Labrum nearly as long as broad, slightly narrowed dorsally, bilobed; anterior surface of each lobe with two minute hairs and/or sensilla and a few rows of minute spinules; ventral border of each lobe with one isolated and two contiguous sensilla and several minute spinules; posterior surface of each lobe with one large and three minute sensilla arranged in a sublongitudinal row; posterior surface spinulose, the middle three-fifths of the dorsal half with numerous subtransverse rows of minute spinules, fewer rows elsewhere. Mandibles moderately sclerotized, subtriangular in anterior view; apex forming a rather long tooth which is curved medially and posteriorly; two stout round-pointed medial teeth (the subapical anterior and the proximal posterior) separated by a denticulate cavity. Maxillae with the apex conoidal, directed ventromedially and sparsely spinulose, the spinules minute and in short rows; palp subcylindrical, with four apical (two with a cap and two with a spinule) and one subapical (with a spinule) sensilla; galea a tall frustum with two apical sensilla, each bearing a spinule. Labium with the anterior surface sparsely spinulose, the spinules exceedingly minute and in short transverse rows; palp a short peg, with four apical (two with a cap and two with a spinule) and one subapical (with a spinule) sensilla; opening of sericteries a short slit on the anterior surface. (Material studied: six larvae from Turkestan.)

BIBLIOGRAPHY

Eidmann, H. *Die Ameisenfauna von Fernando Poo.* Zool. Jahrb. (Abt. Syst.) **76:** 413–490, 1 pl., 17 text figs. 1944.

Emery, C. *Études sur les Myrmicinae.* Ann. Soc. Ent. Belg. **56:** 94–105, 5 figs. 1912.

———. *Fam. Formicidae Subfam. Myrmicinae.* Genera insectorum, fasc. 174: 397 pp., 7 pls. 1921/22.

Forel, A. *Sur le genre* Metapone *n. g. Nouveau groupe des formicides et sur quelques autres formes nouvelles.* Rev. Suisse Zool. **19:** 445–459, 1 pl. 1911.

Wheeler, W. M. *The ants of the genus* Metapone *Forel.* Ann. Ent. Soc. Amer. **12:** 173–191, 7 figs. 1919.

ZOOLOGY.—Valletofolliculina bicornis, *a unique new genus and species of folliculinid (Ciliata: Heterotricha) from California.* E. A. Andrews, Johns Hopkins University. (Communicated by Edward G. Reinhard.)

Ciliated Protozoa of the family Folliculinidae are found in the Atlantic and Pacific, north and south, living each in its own bottlelike dwelling, theca or test, but each is capable of doing away with its complicated feeding apparatus and assuming a simplified actively swimming phase. This swimming phase is of brief duration and ends in the making of a new dwelling like the former one. These tests are chitinlike and durable and present differences in size, form, and structure used to distinguish species and genera.

Some tests sent me from California represent a new species and genus as having sculpturing unlike that of any known form, of which 68 species and 28 genera are found in the great work of Hadzi (1951). These tests were very abundant on all small bivalve shells dredged April 7, 1951; but at the same place none were found in July; so it is feared these folliculinids may be nomads, as others in the Chesapeake (Andrews, 1950), and not readily found again to furnish the needed information as to how these tests originate. As yet we have only preserved tests and no information about the living animal.

DESCRIPTION

As seen in the photograph (Fig. 1), the tests stand in small groups scattered over all the inner face of bivalve shells except the border, which is clear as probably being on the ground where the shell lay inside down. Apparently there was access above at the raised umbo into the quiet water area under the shell, so that the folliculinid swimmers went in in conformity with the habit of folliculinids to settle in depressions, cavities, or circumscribed areas. In any group (Fig. 5) it is noteworthy that the tests stand radiating outward from a vague center: often two side by side or at angles to one nother, giving the impression that when parking in a group the swimmers had been influenced by each other. Each test (Figs. 2–4) has a very much elongated pear shape, lying attached most of its length as a body with rounded posterior, tapering gradually to a slender neck that rises upward, as seen in side view (Fig. 3). From the narrowest front of the neck suddenly flares out a wide funnellike mouth, suggesting a convolvulus flower. Quite unique is the presence of two ridges, like ramparts, along the right and left edges of the roof of the body of the test. These ridges converge anteriorly to dwindling points but posteriorly to swellings, each of which is produced as a horn that rises upward and outward. The two swellings and horns are generally not opposite, but either the right one or the left one is nearer the hind end of the test. It is to be emphasized that the horns and the ridges are not solid, but hollow, each being a space covered with membrane as is the main dwelling space. Thus there are five separated cavities: the main dwelling cavity, the two of

Figs. 1–3.—Photographs of tests of *Valletofolliculina bicornis*; n. gen., n. sp., by John Spurbeck: 1, Inner face of isolated shell of a small bivalve, thickset with tests, in scattered groups (some vague rounded objects are *Cyanea scyphistomas*); 2, top view of ceramic model of a test; 3, side view of another model of a second specimen.

the ridges, and the two of the horns. The roof of the dwelling space cuts it off from both ridge spaces, and the membrane of each ridge space cuts it off from the cavity of its horn.

In paraffine sections each horn has a somewhat pyramidal base continued as a long tapering cylinder, ending abruptly as if truncated, with small rounded end that seems roughened under low powers but under immersion lens presents 20 to 30 projecting hollow spines estimated as 20 to 50 mu long, of uniform, more than one mu diameter, as if tubular outgrowths of the membrane covering the horn and open at each end.

As seen in Figs. 2–4, the colletoderm or cement that fixes the test to the substratum is wide and well defined, forming a halo about the test body as seen from above. When it and the test are scraped off from the substratum together, its width brings it to a horizontal position of rest even in such viscid mounting media as "permount" of the Fisher Scientific Co. of New York; hence side views of the tests are difficult to obtain, though tests on vertical parts of shells (as on left of Fig. 1) show side views. In cross section (Fig. 6) the cement runs far out right and left beyond the floor it forms for the test; hence when the test is removed from the cement, as in Fig. 7, there is a long narrow vacancy ending sharply in front representing the floor of the test. The boundary of this space is comparable to the "water line" of ship building which runs toward a point under the bows. Note in Fig. 6 that while a hollow ridge is cut on the left a swelling and horn are cut on the right, as being nearer to the posterior end of the ridge.

The tests are large enough to be plainly seen on a white background, Fig. 1, and yield the following measurements, in mu. Fifty tests ranged from 550 to 795, with average of 635; however, these were measured straight from mouth to hind end and hence somewhat less than whole length if measured on the side along the horizontal body and uprising neck. Forty-six tests gave body widths of 106–265, with average of 198. Fifty-one specimens had neck widths 90–116, average 101. Forty-two specimens gave mouth widths of 148–212, with average 179: thus often twice as wide as the neck just below it. When side views are obtained it is evident that here, as in many folliculinids, the test is somewhat flattened, the depth being less than the width. With the above average body width of 198, three depths were 104, 125, and 206; and for the above neck width average of 101, three measurements of depths were 78, 90, and 100. The body dwindles forward not only in width but also in depth; one was 125 deep posteriorly but only 100 anteriorly, where becoming the neck.

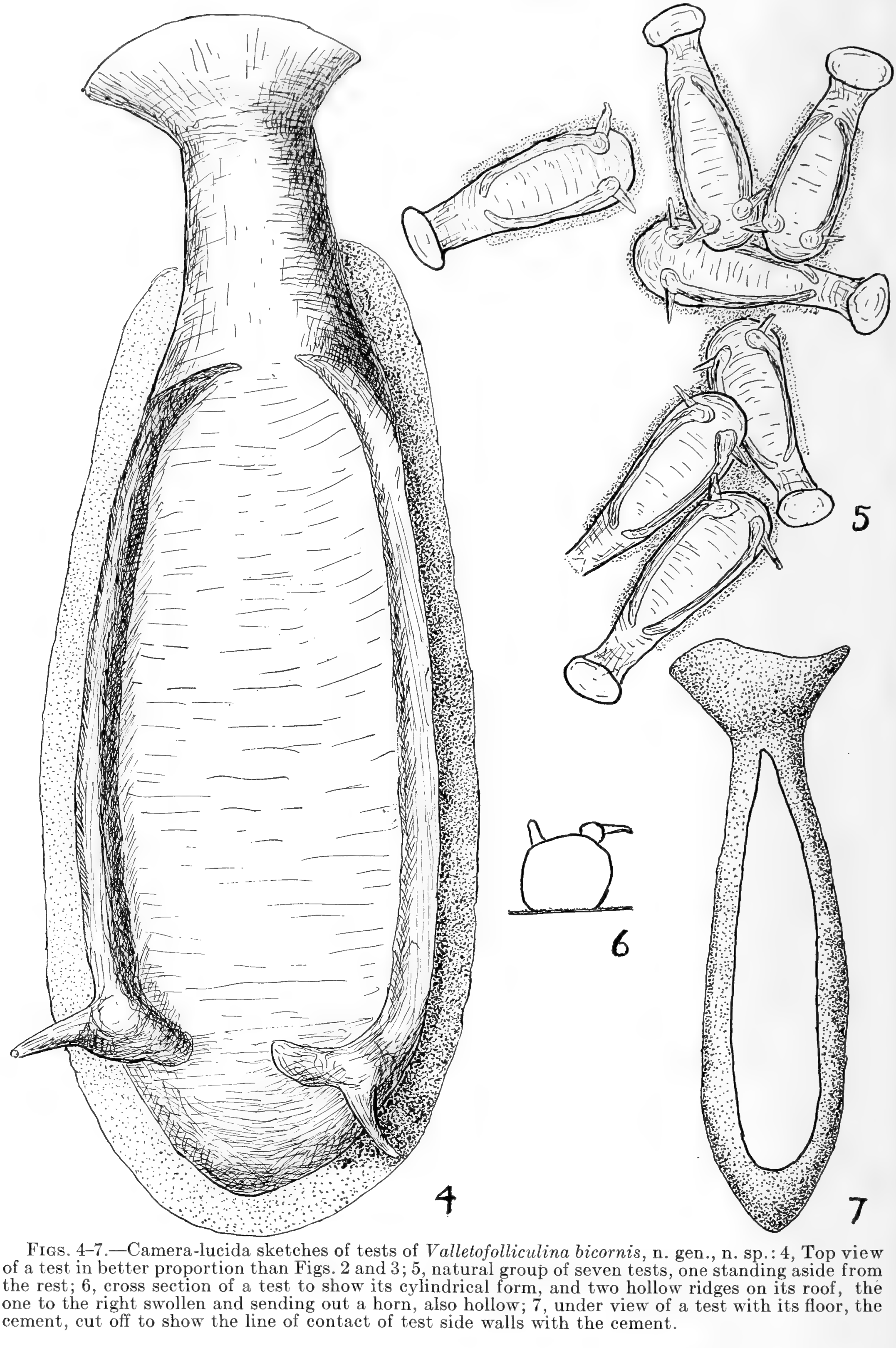
Some other measurements follow. The cement stands out beyond the test as seen from above, like a halo 20 to 78 wide. The ridges are 10–78 in height. The anterior tips of the ridges are 88–120 apart, leaving about 20 spaces from the edge of the body. The horns range from 75 to 125 in length and may be quite unequal, as 78 on the left and 125 on the right. Their tips stand 100–150 apart.

The meganucleus is spheroidal and measured 52, 56, 60, and 60 in diameter of four specimens; over it the color stripes were about 5 mu apart. The food vacuoles are generally anterior to the nucleus; some few were in the peristomial lobes. In one specimen a large object 35 mu long was going into the oesophagus, which was 85 from the tip of the lobes.

The dark green of the animal is lighter in the test where the ridges are rather red-brown, while both cement and horns are colorless.

This new folliculinid from California has considerable resemblance to one called *Parafolliculina roestensis* by Dons, who (1931) dredged it on shells in similar latitudes of the west coast of Norway; both have wide halos of cement about long pear-shaped recumbent tests with short necks ending in wide flaring mouths, and photographs of both show like clustering in small colonies. But Dons makes no mention of dorsal ridges, yet speaks of a local thickening of 40 mu in position corresponding to one of the posterior swellings of the new species, a resemblance increased by the occurrence of an abnormality in one of our specimens in which one ridge bore two blunt elevations in place of the usual swelling and horn. However, Dons' species had a characteristic median pouch from the main cavity at the foot end and two valves that were right and left plates, a feature not found in any other folliculinid. The California specimens looked so much like Dons' figures we expected to see lateral valves and for a time so interpreted the sides of the neck rising from the cement! Some future observations may decide if possibly Dons was misled as to the presence of lateral valves!

Hollow dorsal ridges along the roof of the body of the test being something known only in this new Californian species, we deem it of generic



Figs. 4–7.—Camera-lucida sketches of tests of *Valletofolliculina bicornis*, n. gen., n. sp.: 4, Top view of a test in better proportion than Figs. 2 and 3; 5, natural group of seven tests, one standing aside from the rest; 6, cross section of a test to show its cylindrical form, and two hollow ridges on its roof, the one to the right swollen and sending out a horn, also hollow; 7, under view of a test with its floor, the cement, cut off to show the line of contact of test side walls with the cement.

value; and as the two ridges converge both anteriorly and posteriorly they tend to circumscribe a dorsal area as if by walls, and so we devise the generic name **Valletofolliculina** for this genus and the name **bicornis** for this species.

Its chief characters are: Hollow dorsal ridges prolonged as hollow horns with complex ending; wide flaring mouth from very narrow end of short uprising neck; long pear-shaped reclining body; wide cement; no internal valves; and meganucleus of one lobe.

The posterior end of the test does not show a pit as Dons found, and as far as preserved specimens reveal the tail end of the animal is rounded and often broken loose from the test.

Dredged April 7, 1951, 8–10 feet, 30 per cent salinity in Tomales Bay, Calif., on inner face of bivalve shells, 1 inch and less in length. Tests scattered in groups of up to seven.

DISCUSSION

The chief architectural effects produced by folliculinids result, as in human habitations, from the placement and form of cavities and their walls, and not from solid masses as in crystal aggregates.

As far as known, all skeletal structures in folliculinids arise from the outer surfaces of active protoplasm, by secretion and accompanying activity of cilia. Here ciliary activity accompanies secretion as in many metazoa, notably molluscs and vertebrates. But having made superficial skeletal structures, cement, tests, valves, etc., the protoplasm *retires* and leaves the secreted exoskeleton to permanently represent the former outline and location of the active protoplasm. Even the spiral ridges on the necks of many kinds of folliculinid tests are not simple solids but made up of layers, as long since recognized by Wright (1859), and arise from special ciliary and secretion activities (Andrews, 1923; Das, 1947).

Some of the marked architectural effects caused by cavities and their walls in folliculinids are the following: Many have front halls or atria which in *Parafolliculina* often have side alcoves; the genus *Pebrilla* has the dwelling cavity marked off into anterior and posterior rooms by an external construction, which is not made by outside compulsion but, as Fauré-Fremiet saw (1936), by special action of the swimming phase, in constructing first the posterior chamber and later adding an anterior room. There may be also median posterior outpushings of the main chamber as seen in *Pebrilla*, in the above *Parafolliculina roestensis*, and as a long tubular affair in the upstanding stalked *Pseudofolliculina mellita* (Laackmann) (Dons, 1927) from deep Antarctic waters. Test walls may show numerous outpushings or subordinate chambers as seen by Silen (1947) in some *Folliculina gigantea* if crowded against others, with pouches on each side of an obstacle, and Dons (1927) figures some individuals of *Lagotia simplex* with side alcoves from the test bodies; finally, in the remarkable *Mirofolliculina limnoriae* (Giard) (Dons, 1927) many and variable pouches from the main chamber become a generic character. These folliculinids settle upon rough surfaces of the outside of the wood-boring isopod *Limnoria*, and Fauré-Fremiet thought the pouches were formed by the secretions of the artificer flowing out about obstructing roughnesses, hairs, of the substrate. We note that the protoplasm that makes these pouch walls may remain anchored to the bottom of each pouch as in one figure of Fauré-Fremiet, or it may withdraw as in another figure and as represented by Giard. In many specimens of this species sent me from Friday Harbor, Wash., by Dr. John Buck there are many instances of such withdrawals of plasma from former secretions; and many show the pouches not all on one level, but posteriorly and laterally, below and above, as if the test had "broken out" in pustules, suggesting to me that obstacles to outflow of the plasm in test making cause a general irritation that results in pouch formation far from the points of contact.

With the above facts in mind, we have only to assume the test-making phase of *Valletofolliculina bicornis* has special protoplasmic dorsal ridges; to modify what is known of test making in some other folliculinids and postulate, the test is made as follows. The swimming phase, after gliding over a suitable building site, relaxes as if a mere drop wetting the substrate and then secretes over the part of the substrate it covers the attaching cement, whose form and size will record the form and size of the animal at that period; next it resumes a cylindrical form but with two protoplasmic ridges along its upper face, each of which projects as a hornlike pseudopod ending with some filose activity suggesting the anchoring organs of stentor (Andrews, 1945) but yet not forming the real anchoring organ. This protoplasmic cylinder with ridges then secretes the covering of chitin-like exoskeleton that will remain as the record of the form and position the protoplasm then had. The tips of the pseudopods appear to act somewhat as in forming a scopula, as found in vorticellids as made out by Fauré-Fremiet (1905); the rest of the pseudopod secretes the walls of the horns and then retires into the mass of the ridges. As the ridges secrete their covering it cuts them off from the cavities of the horns, and later when the entire cylinder forms its secreted covering it cuts off the dwelling cavity from the cavities in the ridges from which the plasm retreats into the main mass of the cylinder.

No uses are known for the ridges or the horns. Possibly the ridges might give some protection against the rasping effect of some wandering gastropod's horny teeth. Conceivably the filose activity at the tips of the pseudopods might have some sensory part to play in parking of tests in groups!

LITERATURE CITED

Andrews, E. A. Folliculina: *Case making, anatomy and transformation.* Journ. Morph. **38:** 207–278. 1923.

———. *Stentor's anchoring organs.* Journ. Morph. **77:** 219–232. 1945.

———. *Folliculinids of the Chesapeake as nomads.* Journ. Marine Res. **9:** 21–28. 1950.

Das, S. M. *The biology of two species of Folliculinidae (Ciliata, Heterotricha) found at Cullercoats, etc.* Proc. Zool. Soc. London **117:** 441–456. 1947.

Dons, C. *Folliculina-Studien I–III.* Arch. Protistenk. **27:** 73–93. 1912.

———. *Neue und wenig bekannte Protozoen.* Norske Vid. Selsk. Skrifter 1927 (7): 1–17. 1927.

———. Parafolliculina röstensis *n.sp.* Norske Vid. Selsk. Forh. **3:** 173–176. 1931.

Fauré-Fremiet, E. *La structure de l'apparete fixateur chez les Vorticellidae.* Arch. Protistenk. **8:** 207–226. 1905.

———. *La famille des Folliculinidae (Infusoria Heterotricha).* Mém. Mus. Hist. Nat. Belgique, ser. 2, **3:** 1129–1175. 1936.

Giard, A. *Fragments biologiques XIII. Sur les genres* Folliculina *et* Pebrilla. Bull. Sci. France et Belgique, ser. 3, **1:** Paris, 1888.

Hadzi, J. *Studien ueber Folliculiniden.* Academia scientiarium et artium slovenica. Institutum biologiae **2:** 1–390. Ljubljana, Yugoslavia, 1951.

Laackmann, H. *Zur Kenntnis der heterotrichen Infusorien gattung* Folliculina *Lamarck.* Deutsche Südpolar Expedition, 1901–1903, 12, Zool. **4:** 77–89. 1910.

Silén, Lars. *On Folliculinidae (Ciliophora Heterotricha) from the west coast of Sweden.* Ark. Zool. **39A** (12): 1–68. 1947.

Wright, T. S. 1859. *Description of new Protozoa.* Edinburgh New Philos. Journ. **10:** 97–104. 1859.

ZOOLOGY.—*A new cyprid ostracod from Maryland.*[1] Edward Ferguson, Jr.,[2] Orangeburg, S. C. (Communicated by Willis L. Tressler.)

Two females and one male ostracod belonging to a new species of the genus *Candona* were collected during January 1951 from a drainage ditch on Eldon Hall farm near Princess Anne (Somerset County) Md. This paper describes the new species *Candona hoffi*, named in recognition of C. Clayton Hoff, an outstanding contemporary investigator of American fresh-water Ostracoda.

Genus **Candona** Baird, 1845

The valves of members of this genus are white, sometimes transparent, occasionally with a mother-of-pearl sheen. The surface of the valves is smooth, sometimes with hairs. The shape of the shell varies, generally elongated ovoid to reniform and in some representatives the dorsal margin is straight and the ends are truncate. The swimming setae of the antennae are absent; the antenna of the female has five podomeres, and that of the male has six podomeres that result from the division of the penultimate podomere. The penultimate and ultimate podomeres of the mandibular palp are short and rounded. The respiratory plate of the first thoracic appendage is rudimentary, usually provided with two unequal setae, and never with more than three setae. The third thoracic appendage, which frequently has four podomeres, sometimes appears to consist of five podomeres through a division of the penultimate podomere. The terminal podomere of the third thoracic appendage is short and bears two backwardly directed setae. The furcal ramus is exceptionally well developed and bears two strong claws and one or two setae.

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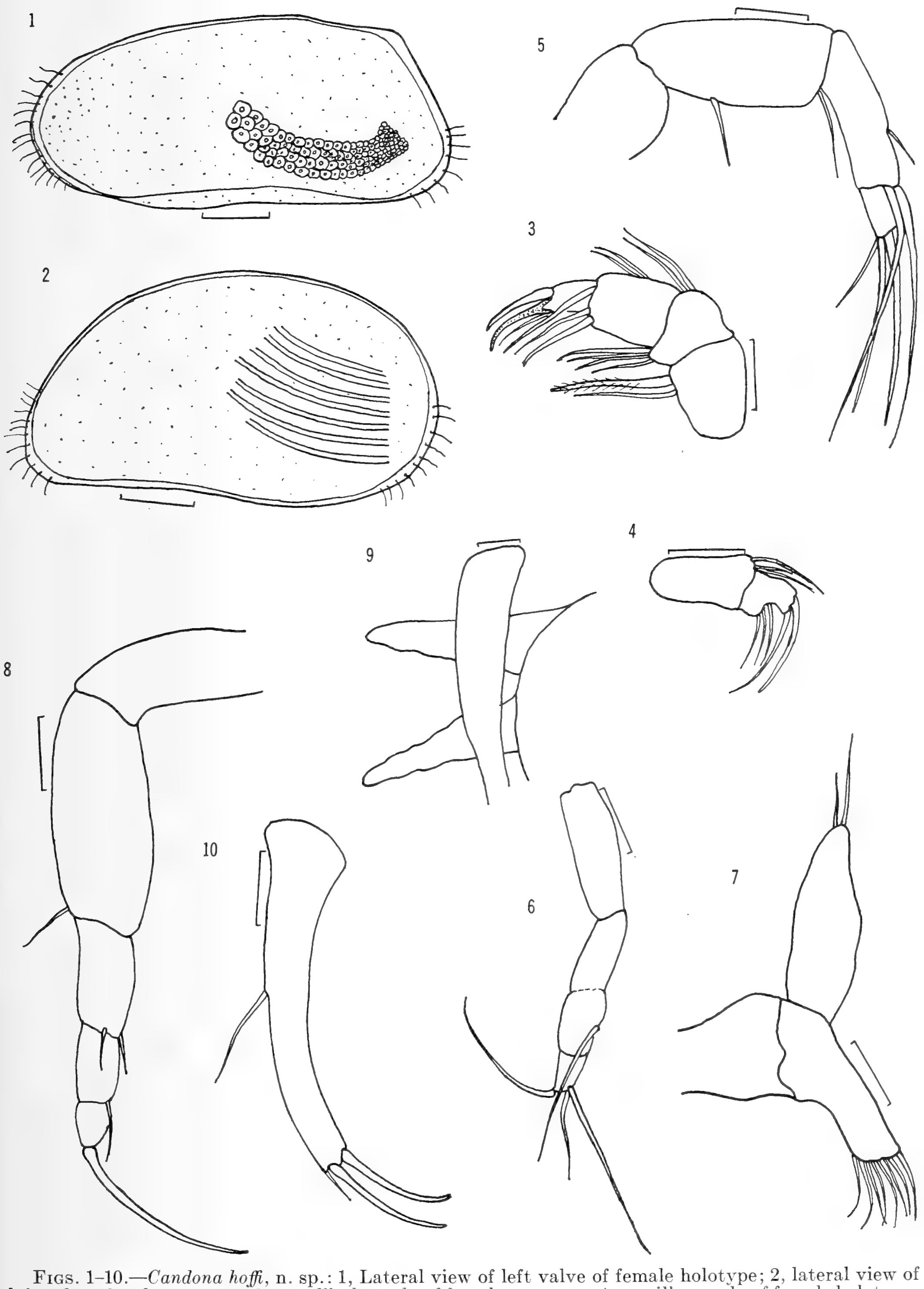
[1] A contribution from the Department of Biology of the State A. and M. College, Orangeburg, S. C.

[2] Appreciation is expressed to Dr. Willis L. Tressler, of the United States Navy Hydrographic Office, for his aid in the preparation of the drawings.



FIGS. 1–10.—*Candona hoffi*, n. sp.: 1, Lateral view of left valve of female holotype; 2, lateral view of left valve of male paratype; 3, mandibular palp of female paratype; 4, maxillary palp of female holotype; 5, left antenna of female paratype; 6, third thoracic appendage of female holotype; 7, first thoracic appendage of female holotype; 8, second thoracic appendage of female paratype; 9, genital lobes and proximal end of furca of female paratype; 10, left furca of female paratype. (All drawings were made with the aid of a camera lucida from specimens stained with acid fuchsin and mounted in Canada balsam. The scale in Figs. 1 and 2 equals 0.20 mm; the scale in Figs. 3–10 equals 0.40 mm.)

The genus *Candona* has not previously been reported from the State of Maryland. Forty-one species of the genus have been reported from North America; of this number 27 species have type localities in the United States. Turner (1894, 1895) described three species, two from Georgia and one from Delaware. Sharpe (1897) described three species from Illinois. Furtos (1933) reported 12 new species from Ohio; Dobbin (1941) described one new species from the State of Washington, and Hoff (1942) reported eight new species from Illinois.

Candona hoffi, n. sp.

Shell.—From the lateral view the left valve of the female (Fig. 1) has a rounded anterior margin and an almost straight dorsal margin. The posterior margin is truncate, and projects slightly at the postero-ventral angle. The ventral margin has a slight sinuation near the center. A few hairs are present along the anterior border, and also on the ventral margin of the posterior border. The surface of the valve is smooth; numerous irregularly shaped dots are seen in valves stained with a 0.5 percent aqueous acid fuchsin. The shell is widest at or near the center, with the greatest width approximately one-half of the length. The ovaries are located in the postero-ventral region of the valve.

The left valve of the male (Fig. 2) differs in shape from that of the female. The anterior and posterior margins are both rounded. The ventral margin is slightly sinuate near the anterior end; the dorsal margin is convex. Hairs and irregularly shaped dots as in the female. The testes are situated in the posterior part of the shell.

The left valve of the single male specimen measured approximately 1.17 mm in length and 0.74 mm in height. The left valve of the female holotype measured approximately 1.10 mm in length and 0.52 mm in height. The permanent mount of the male specimen was broken accidentally, consequently all descriptions of the appendages are from females.

Cephalic appendages.—The antennules do not show any distinct specific characters.

The antennae have five podomeres; natatory setae are absent. The terminal end of the ultimate and the distal end of the penultimate podomeres each with a spine-like seta (Fig. 5). The sense organ is situated near the proximal end of the antepenultimate podomere.

The mandibular palp (Fig. 3) is composed of four podomeres; the terminal podomere is oval with its greatest width equal to the length. The distal end of the dorsal margin of the penultimate podomere is armed with three setae; the ultimate podomere has two strong terminal spines. A bundle of four setae is situated on the inner margin of the antepenultimate podomere.

The maxilla is composed of three lobes. The maxillary palp (Fig. 4) is formed of two podomeres; the proximal one bears three terminal setae on its dorsal, distal margin. The distal podomere is approximately one-half the length of the proximal one, and bears on its ventral margin three setae of approximately equal length; two spinelike setae are situated on the free end of the distal podomere.

Thoracic appendages.—The first thoracic appendage (Fig. 7) is composed of two podomeres; one podomere is perpendicular to the other. The free end of the vertical podomere bears two unequal respiratory setae.

The second thoracic appendage (Fig. 8) has five podomeres. The antepenultimate podomere is slightly longer than the penultimate one. The second podomere is longer than the combined lengths of the antepenultimate and penultimate podomeres.

The third thoracic appendage bears five podomeres, four of which are shown in Fig. 6. The five podomeres result from the division of the long penultimate podomere. Located on the distal one-third of the penultimate podomere is a long seta that extends well beyond the terminal part of the ultimate podomere. The ultimate podomere bears two long terminal setae of approximately equal length and oppositely directed.

The furca.—The furca (Fig. 10) is well developed and distinctly curved. The length of the ventral margin is approximately 10 times the least width of the ramus. The dorsal seta has a length approximately 3 times the least width of the ramus. The length of the terminal seta is approximately 12 times its least width. The furca has two strong terminal spines of approximately equal length.

Reproductive organs.—The ovaries are located in the postero-ventral region of the valve (Fig. 1). The genital lobe (Fig. 9) is bifurcated; the ventral lobe is slightly longer and more pointed than the dorsal. The lobes project posteriorly between the furcal rami.

Remarks.—The structure of the genital lobes and the bundle of 4 setae on the antepenultimate podomere of the mandibular palp in *C. hoffi* are diagnostic characters of the Acuminata group. The new species resembles *C. acuta* Hoff, 1942, very closely; however, the two species may be readily distinguished by the structural differences of the reproductive organs. Hoff (1942) describes the ovary of *C. acuta* thus: "The ovary appears as a narrow band, posteriorly much more narrowed than in most Candona." The ovary of *C. hoffi* forms a relatively wide band of uniform width over its entire length. In *C. acuta* the genital lobe as shown by Hoff (1942: fig. 69) is a single rounded structure barely reaching beyond the dorsal ramus of the furca. The genital lobe in *C. hoffi* is bifurcated; the ventral lobe is longer and more pointed than the dorsal. Both lobes extend well beyond the dorsal ramus of the furca.

Type locality.—The type specimens were collected on January 11 and 25, 1951 from a drainage ditch on Eldon Hall farm near Princess Anne (Somerset County) Maryland. The temperature of the air and water was 0 degrees Centigrade on January 25; collections on this date were made from water covered by a thin sheet of ice. The muddy water that was always present also served as the habitat for green algae of several kinds, for numerous rotifers, and for the ostracod *Cypridopsis vidua.*

Type specimens.—The two stained permanent mounts of dissected specimens from which the description of the new species reported in this paper was made have been deposited in the U. S. National Museum, nos. 93561 and 93562.

LITERATURE CITED

DOBBIN, CATHERINE N. *Fresh-water Ostracoda from Washington and other western localities.* Univ. Washington Publ. Biol. **4:** 174–246. 1941.

FURTOS, NORMA C. *Ostracoda of Ohio.* Ohio Biol. Surv. **5:** 411–524. 1933.

HOFF, C. CLAYTON. *Ostracoda of Illinois, their biology and taxonomy.* Illinois Biol. Monogr. **19:** 1–196. 1942.

SHARPE, RICHARD W. *Contribution to a knowledge of the North American fresh-water Ostracoda included in the families Cytheridae and Cyprididae.* Bull. Illinois Lab. Nat. Hist. **4:** 414–484. 1897.

TURNER, CHARLES H. *Notes on American Ostracoda, with descriptions of new species.* Bull. Sci. Lab. Denison Univ. **8:** 13–26. 1894.

———. *Fresh-water Ostracoda of the United States.* 2d Rep. State Zoologist Minnesota: 277–337. 1895.

MAMMALOGY.—*Three new lemmings* (Dicrostonyx) *from Arctic America.*

CHARLES O. HANDLEY, JR., United States National Museum.

A revisionary study of the varying or collared lemmings of the genus *Dicrostonyx* has shown that three American populations differ from known races by well-marked distinguishing characters and should be recognized by name. I am indebted to the American Museum of Natural History, the Harvard University Museum of Comparative Zoology, the National Museum of Canada, and the University of California Museum of Vertebrate Zoology for the loan of comparative material. In the following discussions, specimens from these museums are indicated by the abbreviations AMNH, MCZ, NMC, and MVZ, respectively, and those from the United States National Museum, including the Biological Surveys Collection, by US. I am particularly grateful to the National Museum of Canada and the U. S. Fish and Wildlife Service for the privilege of designating specimens from the collections in their care as types. Capitalized color terms are from Ridgway, 1912, *Color standards and color nomenclature.* All measurements are in millimeters and are given as averages followed by extremes.

Dicrostonyx groenlandicus clarus, n. subsp.

Type.—U. S. N. M. no. 290952; old adult male, skin and skull; collected June 16, 1949, by Charles O. Handley, Jr.; near sea-level at Cherie Bay, 5.4 miles ENE. of Mould Bay Station, Prince Patrick Island, District of Franklin, Northwest Territories, Canada (lat. 76° 19′ N., long. 119° 02′ W.); collector's number 1285.

Distribution.—The Parry Islands of the Canadian Arctic Archipelago. Specimens are available only from Melville, Prince Patrick, and South Borden Islands, but the range probably includes also Ellef Ringnes Island, the Bathurst Islands, and other smaller islands of this general area. Zonal range: Arctic.

Description.—Adult summer coloration: Mass effect bright gray above; dorsum, except for lighter areas on shoulders, rather uniformly colored from snout to tail; light band on dorsal hairs typically pure white; subapical orange band on dorsal hairs narrow or absent and contributing little to mass color effect; orange of sides typically invading dorsum in shoulder region only slightly; faint but readily discernible black median dorsal stripe extending from snout to base of tail; rump gray; ear patches between Sanford's Brown and Amber Brown; tail and feet whitish; belly washed with orange ranging in hue from Pale Ochraceous-Buff to Sanford's Brown, darkest color concentrated along midline and on chest, forming an obscure collar; flanks, especially at base of fore leg, tinged with orange of same hue as belly. Juvenal summer coloration: Dorsum grayish-brown, varying with season and individual from Snuff Brown to Sudan Brown; shoulders lighter than remainder of dorsum; black median dorsal stripe well defined and extending from forehead to base of tail; underparts varying from buffy to almost white; throat collar poorly developed. Winter pelage: white. Size large; tail long. Skull large, but light and lacking extreme angularity; rostrum long and narrow; dorsal root of premaxilla narrow; maxillary part of zygoma strongly notched on anterior surface and protruded on posterior surface above infraorbital canal; supraorbital ridges of frontals generally weakly developed; postorbital process of squamosal poorly developed; zygomata light and parallel to one another in outline; temporal ridges poorly developed, but lambdoidal crest strong; brain case large; auditory bullae relatively small; molars light, triangle pattern compressed antero-posteriorly.

Measurements.—Twelve old adults, including the type, from Prince Patrick Island: Total length, 146 (140–154); tail vertebrae, 26 (23–28); hind foot, 21 (19–23); greatest length of skull, 32.4 (31.3–33.5); length of brain case (from dorsal midpoint of foramen magnum to antriormost projection of parietal), 12.9 (11.5-13.8); median length of nasals, 9.0 (8.5–9.4); greatest breadth of combined nasals, 3.8 (3.4–4.0); least interorbital breadth, 3.9 (3.6–4.2); maximum zygomatic breadth, 20.6 (19.4–21.3); breadth of brain case (at constriction behind postorbital processes of squamosals), 13.4 (13.0–13.9); alveolar length of maxillary molar row, 8.2 (8.0–8.5).

Comparisons.—Two races require comparison with *clarus*; *groenlandicus* inhabiting the islands to the eastward, and *kilangmiutak* those to the south. In adult summer coloration *clarus* resembles *groenlandicus* in having the dorsum almost clear black and white and largely lacking orange. However, the black tips of the dorsal hairs are not as long in *clarus*, and a grayer dorsal coloration results. Other characters distinguishing *clarus* are: black median dorsal stripe more pronounced; rump grayer; flanks less bright; underparts considerably paler; throat collar and median ventral stripe better defined. In juvenal summer coloration, *clarus* is darker, more brownish dorsally, and has the median dorsal stripe better defined and more extensive. The skull of *clarus* is similar in general to that of *groenlandicus*, but shows the following differences: lighter and less angular; nasals somewhat shorter; dorsal root of premaxilla narrow; supraorbital ridges less strongly developed and usually well separated; zygomata parallel-sided and not rounded in outline; brain case longer; triangle pattern of molars more compressed; auditory bullae less inflated.

From *kilangmiutak*, summer adult *clarus* differs as follows: dorsum more grayish, and lacking pinkish cast in the shoulder region; ear patches darker; orange flank color darker, less pinkish, and less extensive; orange median ventral stripe longer and better defined. In juvenal summer pelage: slightly darker dorsally; median dorsal stripe slightly better defined; throat collar less developed. The skull of *clarus* differs significantly from that of *kilangmiutak* in having much larger size, more angular and heavier construction, longer rostrum and nasals, wider nasals, less developed supraorbital ridges, more conspicuously notched zygoma (anteriorly above infraorbital canal), more parallel sided zygomata, narrower dorsal root of premaxilla, and more prominent temporal ridges.

Specimens examined.—Canada, N.W.T.: MELVILLE ISLAND, Liddon Gulf, 1 (NMC); Winter Harbor, 5 (US); no specific locality, 1 (NMC). PRINCE PATRICK ISLAND, vicinity of Mould Bay, 99 (NMC), 68 (US). SOUTH BORDEN ISLAND, south coast, 1 (NMC).

Dicrostonyx groenlandicus lentus, n. subsp.

Type.—Nat. Mus. Canada no. 11404; old adult male; skin and broken skull; collected June 13, 1931, by J. Dewey Soper at Lake Harbor, Baffin Island, District of Franklin, Northwest Territories, Canada (62° 43′ N., 69° 41′ W.); collector's number 2384.

Distribution.—Approximately the southern half of Baffin Island, Northwest Territories, Canada. North at least to Nettilling Lake and

Cape Mercy; south to Hudson Strait. Zonal range: Arctic.

Description.—Adult summer coloration: Black in dorsal pelage reduced and light band on dorsal hairs pale buff, rendering mass effect between Avellaneous and Drab; black median dorsal stripe not well defined; ear patch Ochraceous-Tawny; feet and tail whitish; orange wash on flanks reduced and not extending on dorsum in shoulder region; underparts typically pale (Pale Ochraceous-Buff to almost white); throat collar and orange median ventral line pale, but well defined because of lighter background. Juvenal summer coloration: Dorsum relatively dark (Sayal Brown); shoulders scarcely differentiated from remainder of dorsum; black median dorsal line well defined; belly light buff to whitish; throat collar poorly developed. Winter pelage: white. Size small. Skull small, light, and lacking angularity; nasals long and narrow; dorsal root of premaxilla wide; anterior notch and posterior protuberance on zygoma above infraorbital canal poorly developed; supraorbital ridges strongly developed; postorbital process of squamosal well developed; zygomata of very light construction, rounded in outline; maxillary molars small and light, triangle pattern slightly compressed anteroposteriorly.

Measurements.—Four adults (including the type) from southern Baffin Island: Total length, 129 (type only); tail, 18 (type only); hind foot, 12 (type only); greatest length of skull, 29.1 (28.6–29.2); length of brain case, 12.4 (12.4–12.5); median length of nasals, 8.6 (8.4–8.7); greatest breadth of combined nasals, 3.3 (3.1–3.4); least interorbital breadth, 3.7 (3.6–3.8); maximum zygomatic breadth, 18.3 (18.1–18.5); breadth of brain case, 12.3 (12.0–12.6); alveolar length of maxillary molar row 7.2 (6.9–7.4).

Comparisons.—In contrast to the bright *groenlandicus*, *lentus* is dorsally pale and dull in adult summer pelage, a consequence of reduction of black and replacement of white with buff on the individual hairs. It has the black median dorsal stripe better defined, and the flanks and underparts less tinted with orange. In juvenal summer pelage *lentus* is much darker brown dorsally than *groenlandicus*. Cranially, *lentus* is quite similar to *groenlandicus*, differing principally in smaller size and less angularity of the skull. In addition, it lacks the anterior notch and posterior protuberance of the zygoma above the infraorbital canal, and its molars are smaller.

In coloration *lentus* is similar to *hudsonius* but is slightly paler, duller, and more buffy on the dorsum, has a less well defined black median dorsal stripe, has the belly generally lighter and less cinnamon, has the throat collar paler and less extensive, and has a more pronounced orange median ventral line. The dorsum of the juvenal summer pelage is not so yellowish in *lentus*. With regard to the cranium, *lentus* is strikingly smaller and more fragile than *hudsonius*, and lacks angularity. Furthermore, it lacks the great development of the anterior notch and the posterior protuberance above the infraorbital canal on the zygoma, and the heavy, blunt postorbital process of *hudsonius* is replaced by a much smaller structure.

In adult summer coloration, *lentus* is quite unlike *richardsoni*, being much paler and duller in general, less brown and red on the dorsum, much paler on the underparts, and with the black median dorsal stripe poorly developed. The juvenal summer pelage in the two races is similar, except that *lentus* averages somewhat paler and usually has a less prominent black median dorsal stripe. In *lentus* the skull is smaller, somewhat lighter and less angular, the nasals are longer and narrower, and the zygomata are lighter.

Specimens examined.—Canada, NWT, BAFFIN ISLAND: Amadjuak Bay, 6 (NMC); Bowdoin Harbor (Schooner Harbor), 1 (MCZ); Bowman Bay (Camp Kungovik), 1 (NMC); Cape Dorset, 6 (NMC); Cape Mercy, 1 (US); Gordon Bay (Ikkarashuk), 1 (NMC); Lake Harbor, 6 (NMC); Nettilling Lake, 5 (NMC); "southwest coast", 3 (MCZ); "Baffin Island," 2 (MCZ).

Dicrostonyx unalascensis peninsulae, n. subsp.

Type.—U. S. N. M. (Biol. Surv. Coll.) no. 246377; old adult female; skin and skull; collected May 8, 1925, by Olaus J. Murie near sea-level at Urilla Bay, Unimak Island, Alaska; collector's number 1993.

Distribution.—Southwestern Alaska, including Unimak Island, the eastern side of the Alaska Peninsula to Chignik, and the Bering Sea coast from Isanotski Strait to Nushagak. Zonal range: Subarctic.

Description.—Adult summer coloration: Red of flanks extending prominently as a wash on dorsum; subapical orange bands of dorsal hairs wide; black tips of dorsal hairs narrow; total color effect of dorsum reddish-brown, between Tawny and Orange-Cinnamon; nape and cheeks buffy, poorly distinguished from dorsum; ear patches about Sanford's Brown; black median dorsal stripe pronounced; feet and tail whitish; underparts between Pale Yellow-Orange and Light Buff; throat collar wide and dark, but poorly defined (about Amber Brown); well defined median ventral stripe of same color extending from collar to middle of belly. Juvenal summer coloration: Dorsum dark and bright, between Cinnamon-Brown and Dresden Brown in mass effect; cheeks and ear patches similar to remainder of dorsum; black median dorsal stripe well developed; underparts buffy, with poorly defined brownish collar. Winter pelage: At least some individuals white. Size small. Skull small, but heavy and angular in construction; nasals short and wide; zygoma not or only slightly notched anteriorly above infraorbital canal; posterior protuberance of zygoma above infraorbital canal fairly well developed; zygomata heavy and of tear-drop shape in outline, tapering posteriorly; postorbital process of squamosal large and blunt; supraorbital ridges poorly developed; temporal ridges prominent; brain case short and narrowed posteriorly; molars large and heavy; auditory bullae small and not inflated.

Measurements.—Three old adults (including type) from Unimak Island. Total length, 132 (130–133); tail vertebrae, 15 (11–18); hind foot 19 (19–19); greatest length of skull, 28.6 (28.2–28.9); length of brain case, 11.8 (11.5–12.0); median length of nasals, 8.4 (8.3–8.5); greatest breadth of combined nasals, 3.5 (3.4–3.5); least interorbital breadth, 3.8 (3.7–3.8); maximum zygomatic breadth, 18.7 (18.7–18.7); brain-case breadth, 11.7 (11.5–11.9); alveolar length of maxillary molar row 7.6 (7.3–7.9).

Comparisons.—*D. u. peninsulae* must be compared with two other populations: that represented by *D. u. unalascensis* to the south, and that inhabiting the Bering Sea coast to the north. The latter has been considered a segment of *D. groenlandicus rubricatus*, whose type locality is Bering Strait, and whose extensive range includes the arctic coasts of Alaska and Canada. However, the lemmings of the northern Bering Sea coast of Alaska are quite distinct from *rubricatus*, having the skull smaller and lighter, the nasals narrower, the supraorbital ridges stronger, and the dorsal pelage much more brownish in summer. The name *Dicrostonyx nelsoni* Merriam (type locality: St. Michael, Norton Sound, Alaska) is available for this population, which should therefore be called *Dicrostonyx groenlandicus nelsoni.*

In adult summer pelage *D. u. peninsulae* resembles *D. g. nelsoni*, but has the black in the dorsal pelage reduced; the cheeks more buffy; the black median dorsal stripe better developed; the red on the flanks less extensive; the underparts more yellowish; and the throat collar darker. The skull of *peninsulae* is smaller, heavier, and more angular; the nasals and rostrum are shorter and wider, the zygomata are heavy and tear-drop shaped rather than rounded; the postorbital process of the squamosal is larger and blunter; the temporal ridges are stronger; the braincase is shorter and narrower posteriorly; the molars are larger and heavier; and the auditory bullae are smaller and less inflated.

From *D. u. unalascensis* in summer pelage, *peninsulae* differs in having the dorsum lighter, brighter, and more reddish; the flanks more reddish; the black median dorsal stripe better defined; the belly more yellowish, and the throat collar neither so dark nor so extensive. In size, *peninsulae* is much smaller. The skulls of the two forms are almost identical except in size.

Specimens examined.—ALASKA: Chignik, Alaska Peninsula, 1 (US); Muller Bay, Alaska Peninsula, 1 (AMNH); Nushagak, 4 (US); Urilla Bay, Unimak Island, 4 (US).

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JOURNAL
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PALEONTOLOGY.—*A new species of* Carinocrinus *from Oklahoma.*

HARRELL L. STRIMPLE, Bartlesville, Okla. (Communicated by Alfred R. Loeblich, Jr.)

I collected the specimens used in this study from the upper Pitkin formation (Chester) in the Cookson Hills, southeast of Muskogee, Okla. I consider the species to be referable to the genus *Carinocrinus* Laudon, though the arm structure is different from that of *C. stevensi* Laudon, which is the genotype species and only form heretofore known. According to the description and illustration of *C. stevensi*, the first bifurcation does not take place before the fifth primibrachials (PBrBr$_5$), whereas in *C. eventus*, n. sp., the first primibrachials are known to be axillary in at least four of the arms (the anterior ray has two known rami, but the point of branching is questionable). The arms of *C. eventus* are somewhat stouter than those of *C. stevensi* and the dorsal cup of the former species has a relatively greater length due mainly to the unusual length of the basal plates.

Laudon considered *Carinocrinus* to have probably evolved through *Culmicrinus* and was no doubt influenced by the arm structure of *C. stevensi*. The arms of *Culmicrinus* do not commence their isotomous branching until several PBrBr are formed. As noted above, this is not the case in *C. eventus*. I am inclined to consider *Gilmocrinus* Laudon as a possible ancestrial form based on the steeply conical dorsal cup and relatively stout anal sac. *Gilmocrinus* has only five arms; however, strong ramules are present and it is not unreasonable to suppose they could have evolved to regular arms.

Carinocrinus eventus, n. sp.

The dorsal cup is elongate, conical shaped, with infrabasals (IBB) readily visible in side view of the cup. The five IBB rise evenly from the round columnar attachment. Five basals (BB) are considerably longer than wide. Five radials (RR) are pentagonal, slightly wider than long. Three anal plates occupy the posterior interradius. Anal X is in full contact with post. B and extends above well into the interbrachial area. RA is almost vertical in attitude, and contacts r. post. B and post. B below, r. post. R to the right, anal X to the left, and the large RX above.

It is possible to establish at least portions of the arm structure for all five rays by observing the three type specimens. PBrBr do not fill the distal face of RR, and all observed are axillary. The anterior ray is known to have at least two arms but the PBr is missing. A second isotomous branching usually occurs with the seventh to ninth SBrBr. Thereafter, isotomous branching has been observed in most rays with the sixth to seventeenth TBr. In the right posterior ray, another division is found with the seventh QBr. The arms are becoming rather thin as preserved and most likely do not reach the termination of the massive, club shaped anal tube. Nonaxillary brachials are wedge shaped and apparently pinnular. The arms have a well-rounded exterior.

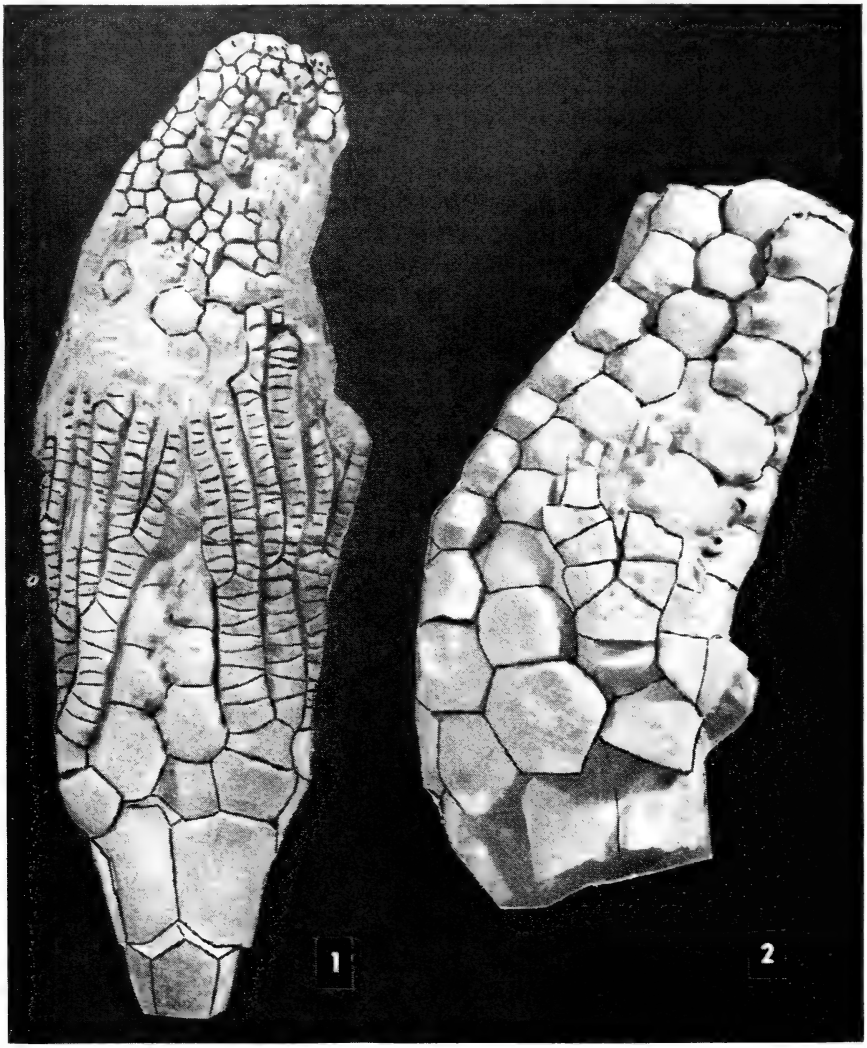
Near its base, and for a considerable portion of its length, the anal sac is composed of circlets of six plates. Along the lateral sides of each tube plate, a pore slit, or pit, is shared with the plate below and another with the adjoining plate to the right or left, as the case may be. The same is true at the upper corners. In addition, there is a pit at midlength of each lateral side which is shared by the apposing plate. This leaves a divergent ridgelike development which passes from one row of plates to the other rows. The slits first appear in the upper portions of anal X and RX, where they are more numerous than outlined above. They are present to a lesser degree in the uppermost portion of the sac; however, in that area there are numerous smaller plates interposed amongst the original circlet of six. Some tendency toward small spine like protrusions has been observed on the terminating plates of the sac, but they are relatively inconspicuous. It appears that the anal tube rises and then reverses directions so that the anal opening is very likely low on the sac. Such development was found in *C. stevensi.*

Remarks.—The outstanding differences between *C. eventus* and *C. stevensi* have been given in the preface to this description. It might be added that *C. eventus* is a more robust form but has a slightly shorter anal sac than found in *C. stevensi.*

Measurements in mm.—As follows:

	C. eventus (holotype)	*C. stevensi* (after Laudon)
Width of dorsal cup	32.2[1]	19
Height of dorsal cup	37.0	22
Width of IBB	8.2	4
Height of IBB	12.0	5
Width of BB	10.3[2]	8
Height of BB	21.1[2]	9
Width of RR	12.6[3]	10
Height of RR	8.8[3]	6
Anal sac, length	94.5	113
Anal sac, width at midlength	21.6	14
Anal sac, width at expanded distal portion	28.5	19

[1] Mildly distorted by compression.
[2] Left posterior basal.
[3] Left posterior radial.



FIGS. 1, 2.—*Carinocrinus eventus*, n. sp.: 1, Holotype from posterior, × 1; 2, paratype from right posterior, × 2.

Occurrence.—Shale break in the upper Pitkin formation, Chester, Mississippian; exposure in the bluffs overlooking the Arkansas River about 1½ miles southwest of Cedar Creek Community, which is south of Oklahoma State Highway 10, between Greenleaf Lake and Gore, Okla. The exposure is the same as the type locality of such forms as *Paianocrinus durus* Strimple, *Bronaughocrinus figuratus* Strimple, *Telikosocrinus caespes* Strimple, and others.

Types.—Holotype and two paratypes are to be deposited in the U. S. National Museum.

REFERENCES

LAUDON, LOWELL R. Journ. Pal. **15:** 390, pl. 57, fig. 5. 1941.

STRIMPLE, HARRELL L. Journ. Washington Acad. Sci. **41:** 260–263, figs. 1–13. 1951.

————. Journ. Pal. **25:** 669–676, pls. 98, 99. 1951.

BOTANY.—*Studies of South American plants, XIII.* A. C. SMITH, U. S. National Museum.

Continuing his study[1] of special families of phanerogams in South America, the writer here describes 11 new species in the families Myristicaceae, Monimiaceae, and Vacciniaceae, discussing various other noteworthy plants in these families and in the Hippocrateaceae and Ericaceae as well. The specimens upon which these notes are based were obtained in recent years by several collectors in the Andean countries from Colombia to Bolivia; most of them are deposited in the U. S. National Herbarium. Mention should also be made of a very valuable series of specimens collected in Colombia and Peru by Christopher Sandeman, kindly forwarded for study by the Director of the Royal Botanic Gardens at Kew. The place of deposit of the specimens here cited is indicated as follows: BM (British Museum [Natural History], London); Ch (Chicago Natural History Museum); Col (Instituto de Ciencias Naturales, Bogotá); K (Royal Botanic Gardens, Kew); NY (New York Botanical Garden); and US (U. S. National Museum).

MYRISTICACEAE

Virola obovata Ducke in Bol. Técn. Inst. Agron. Norte (Belém) **4:** 12. 1945.

COLOMBIA: Amazonas: Picada Cotuhé, *Schultes & Black* 46-359 (US) (open "varial," stream-margin; tree 6 m high; fruit chestnut-colored).

This appears to be the second recorded collection of the species, of which the type comes from the mouth of the Javary in adjacent Brazil. As compared with a duplicate of the type (*Ducke* 1509), our specimen has the leaf-blades narrowly elliptic rather than slightly obovate, and the indument of the lower surface evanescent; the fruit is less developed than that of the type. As mentioned by Ducke, the long hairs with conspicuous lateral spurs, which are persistent on inflorescences and to a certain extent on the branchlets and petioles, characterize the species. It is further distinguished from its apparent allies, *V. calophylla* Warb. and *V. calophylloidea* Markgraf, by its acute leaf-blades. Staminate flowers are still desired accurately to ally the species, but this would seem its probable relationship.

Virola micrantha, sp. nov.

Arbor ad 20 m alta, ramulis juvenilibus gracilibus angulatis leviter flexuosis et partibus novellis copiose stellato-pilosis (pilis sessilibus ad 0.1 mm diametro, radiis 5–8), ramulis mox glabratis teretibus cinerascentibus; foliis pro genere parvis, petiolis leviter canaliculatis gracilibus 3–7 mm longis ut ramulis pilosis, laminis papyraceis vel tenuiter coriaceis in sicco fuscis, elliptico-oblongis, 4.5–7.5 cm longis, 1.8–3.2 cm latis, basi et apice obtusis (vel apice obscure mucronulatis), subtus pilis stellatis sessilibus circiter 0.1 mm diametro plerumque 4–6-radiatis inconspicue ornatis, costa supra leviter impressa subtus prominente, nervis secundariis plerumque utrinsecus 12–15 patentibus supra paullo impressis subtus subplanis, venulis utrinque saepe minute impressis; inflorescentiis ♂ paniculatis multifloris 4–6 cm longis latisque, pedunculo 1.5–2.5 cm longo et ramulis ut partibus vegetativis novellis stellato-pilosis; bracteis sub florum fasciculis submembranaceis deltoideo-orbicularibus circiter 2 mm diametro stellato-pilosis mox glabratis et caducis; floribus sessilibus in fasciculis ultimis 1.5–2.5 mm diametro 6–10 aggregatis;

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[1] No. XII of this series was published in Contr. U. S. Nat. Herb. **29:** 317–393. 1950.

perianthio membranaceo circiter 1 mm longo extus stellato-puberulo fere ad basim 3-lobato, lobis oblongis obtusis; androecio 0.5–0.6 mm longo, stipite gracili utroque paullo contracto, antheris 3 minutis (haud 0.2 mm longis) omnino connatis; planta ♀ ignota.

Colombia: Amazonas: Trapecio Amazónico, Quebrada Agua Preta, November 8, 1946, *R. E. Schultes & G. A. Black* 46-377 (US 1988362 type) (tree 20 m high, in "varial").

This well-marked species, with graceful inflorescences and flowers which are (even for *Virola*) minute, is probably best placed in my species-group *Rugulosae* (cf. Brittonia **2:** 455 seq. 1937), where its closest ally is *V. minutiflora* Ducke. That species, however, has the leaf-blades with 30–38 pairs of secondaries and the flowers pedicellate, larger, and in ultimate clusters of 50–100. The new species also suggests some members of the species-group *Surinamenses*, in particular *V. parviflora* Ducke, but differences in foliage and in flower arrangement and size are obvious.

Virola albidiflora Ducke in Journ. Washington Acad. Sci. **26:** 259. 1936; A. C. Sm. in Brittonia **2:** 486. 1937.

Colombia: Meta: Sierra de la Macarena, Central Mountains, Entrada Ridge, alt. 650 m, *Philipson, Idrobo, & Jaramillo* 2233 (BM, Col, US).

The cited specimen, in fruit, agrees excellently with earlier known material from the Solimões region of Brazil, thus extending the known range of the species into Colombia. The present collection is described as a tree 25 m high, with green fruits, occurring in dense forest.

MONIMIACEAE

Siparuna oligogyna, sp. nov.

Arbor dioica ad 8 m alta vel frutex, ramulis rectis gracilibus subteretibus ad nodos subcomplanatis apices versus sublepidoto-pilosis (pilis pallidis stellatis 0.15–0.3 mm diametro radiis 8–25 centrum versus adnatis); foliis oppositis, petiolis gracilibus leviter canaliculatis 8–17 mm longis ut ramulis pilosis, laminis papyraceis in sicco viridi-olivaceis, obovato- vel lanceolato-ellipticis, 9–18 cm longis, 3.5–6.5 cm latis, basi acutis et in petiolum decurrentibus, apice cuspidatis (apice ipso obtuso ad 1.5 cm longo), margine integris et anguste recurvatis, supra glabris vel secus nervos sparsim stellato-pilosis, subtus pilis eis ramulorum similibus saepe dispersis ornatis, costa supra leviter elevata subtus prominente, nervis secundariis utrinsecus 7–9 arcuato-adscendentibus supra prominulis subtus elevatis, nervis tertiariis transversis et rete venularum utrinque inconspicue prominulis; inflorescentiis ♂ axillaribus solitariis vel binis cymosis 2–3 cm longis multifloris ubique ut ramulis juvenilibus flavescenti-sublepidoto-pilosis, pedunculo 5–10 mm longo, ramis paucis, pedicellis sub anthesi 1–1.2 mm longis; floribus ♂ circiter 2 × 1.5 mm, receptaculo obovoideo tenuiter carnoso margine apicali integro lato, tepalis et velo omnino nullis; staminibus 12–14 subaequalibus liberis leviter exsertis, filamentis membranaceis deltoideo-ligulatis circiter 0.5 mm longis copiose glandulosis, antheris minutis apice obtusis; inflorescentiis ♀ similibus, floribus paucioribus sub anthesi circiter 2.5 mm longis, receptaculo ellipsoideo carnoso ♂ simili, tepalis obsoletis; carpellis 3–5, stylis liberis filiformibus longe exsertis; drupis immaturis obovoideis ad 7 mm longis persistenter pilosis.

Colombia: Meta: Sierra de la Macarena, Río Guapaya, alt. 500 m, January 21, 1950, *W. R. Philipson, J. M. Idrobo, & R. Jaramillo* 2195 (BM, Col, US 2026249 type) (tree 8 m high, in dense humid forest; flowers yellow); same locality, alt. 450 m, *Philipson, Idrobo, & Fernández* 1629 (BM, Col, US) (shrub, in dense forest on bank of river; flowers greenish; fruits green).

The new species is characterized by its small flowers, with obsolete tepals and lacking a velum, and by its indument, which is composed of minute stellate hairs with 8–25 rays connate toward the depressed center. The trichome thus suggests a scale, but since its rays are free for most of their length it is probably best defined as a stellate hair. The closest ally of the new species is the Ecuadorian *S. eggersii* Hieron., which has a similar but sparser indument, leaf-margins usually obviously sinuate-dentate, larger flowers with obvious but small tepals, fewer stamens, and more numerous carpels. The type of *S. oligogyna* is from a staminate plant, while no. 1629 bears pistillate flowers and young fruits.

Siparuna idroboi, sp. nov.

Arbor mediocris, ramulis teretibus copiose stellato-tomentellis (pilis stramineis, radiis plerumque 5–10 adscendentibus longitudine diversis 0.4–0.8 mm longis); foliis oppositis, petiolis gracilibus subteretibus valde diversis 2–6 cm longis ut ramulis dense tomentellis, laminis papyraceis in sicco fusco-viridibus subtus pallidioribus, anguste ellipticis, 15–27 cm longis, 6–11.5 cm latis, basi obtusis vel acutis, ad apicem circiter 1 cm longum calloso-obtusum gradatim angustatis, margine inconspicue undulato-crenulatis, ubique stellato-pilosis, pilis faciei superioris radiis 2–5 adscendentibus 0.2–0.4 mm longis, pilis faciei inferioris et supra ad nervos longioribus, radiis plerumque 5–12 ad 0.5 mm longis, costa supra paullo elevata subtus prominente, nervis secundariis utrinsecus 14–16 erecto-patentibus subrectis supra leviter subtus valde elevatis, rete venularum supra plano subtus prominulo, venulis nonnullis in dentes marginales terminantibus; inflorescentiis ♂ axillaribus cymosis solitariis vel binis multifloris 2–3 cm longis ubique pilis 0.2–0.3 mm longis tomentellis, pedunculo gracili 5–8 mm longo, ramulis paucis basi pedicellorum delapsorum conspicue incrassatis; pedicellis gracilibus sub anthesi 4–5 mm longis, floribus obconicis circiter 3 mm longis et 4 mm latis; receptaculo subcarnoso, limbo patente crenulato e tepalis plerumque 6 rotundatis circiter 1 x 1.5 mm incrassatis composito apice circumdato, velo inconspicuo complanato circiter 0.5 mm lato, ore lato; staminibus 10–12 liberis 2- vel 3-seriatis leviter exsertis, extimis maximis, filamentis carnosis oblongo-deltoideis ad 1.2 mm longis latisque luteo-glandulosis, antheris magnis; inflorescentiis ♀ non visis.

Colombia: Meta: Cordillera La Macarena (extreme northeast), Macizo Renjifo, eastern slopes, alt. 600–1300 m, December 30, 1950–January 5, 1951, *J. M. Idrobo & R. E. Schultes* 846 (US 2026030 type) (medium-sized tree).

The new species is characterized by its large, thin leaves, its copious stellate indument (the hairs of which, however, do not conceal the leaf-surface), its flowers with an inconspicuous crenulate rim of small tepals, its flattened velum, and its 10–12 free stamens. It seems most closely related to the Bolivian *S. cinerea* Perk., from which it is readily distinguished by its large, long-petiolate, acuminate leaves and its more numerous stamens. *Siparuna idroboi* superficially suggests *S. chiridota* (Tul.) A. DC., but that species has the foliage-indument appressed to the leaf-surface rather than ascending, and its stamens are very different, the four marginal stamens surrounding a single central one.

HIPPOCRATEACEAE

Salacia opacifolia (Macbr.) A. C. Sm. in Brittonia **3:** 434. 1940.

Colombia: Amazonas: Trapecio Amazónico, Loretoyacu River, alt. about 100 m, on varzea land, *Schultes & Black* 46-300 (US) (flowers yellow).

This is the first Colombian record of a species known from several collections in Amazonian Peru and adjacent Brazil.

Salacia gigantea Loes. in Verh. Bot. Ver. Brand. **48:** 182. 1907; A. C. Sm. in Brittonia **3:** 450. 1940.

Colombia: Amazonas: Trapecio Amazónico, Loretoyacu River, alt. about 100 m, *Schultes & Black* 8296 (US).

The cited specimen is the third collection of the species known to me, the others being from Brazil (Rio Jurua, the type locality, and Rio Solimões).

Tontelea congestiflora (A. C. Sm.) A. C. Sm. in Brittonia **3:** 496. 1940.

Colombia: Vaupés: Río Kananarí and Cerro Isibukuri, alt. 250–700 m, *García-Barriga* 13806 (US) (shrub 2 m high, the flowers red).

This species has previously been known only from the two Krukoff collections from Amazonian Brazil cited by me. The morphology of the species is of particular interest because it represents a unique condition in *Tontelea*, being the only species of the genus that has entire stigmas opposite the stamens. The Colombian specimen agrees in every fundamental respect with those previously known, its inflorescence (to 3 cm long) and petals (to 2.2 mm long) being slightly larger than those described.

Peritassa laevigata (Hoffmanns.) A. C. Sm. in Brittonia **3:** 508. *fig. 11, a–h.* 1940.

Colombia: Meta: Sierra de la Macarena, Central Mountains, North Ridge, alt. 1400 m., *Philipson & Idrobo* 1944 (BM, Col, US). Vaupés: Maviso, *Romero* 1257 (US).

This widespread and rather variable species is here first recorded from Colombia. Romero notes the local name as "huevo de gato" and states that the fruit is edible.

Cheiloclinium obtusum A. C. Sm. in Brittonia **3:** 545. 1940.

Brazil: Amazonas: Rio Vaupés, between

Ipanoré and confluence with Rio Negro, Igarapé da Chuva, Taracuá, *Schultes & Murça Pires* 9071 (US) (liana, with small yellow flowers).

The cited collection, the second known for the species, agrees excellently with the type, from the vicinity of Iquitos, Peru.

ERICACEAE

Befaria nana A. C. Sm. & Ewan in Contr. U. S. Nat. Herb. **29**: 333. 1950.

VENEZUELA: Zulia: Perijá, alt. 2800–2900 m, *Bro. Ginés* 1985 (US) (small shrub on páramo; flowers red).

Among the interesting specimens recently collected by Brother Ginés in Zulia occurs the second collection of *B. nana*, otherwise known only from the type, obtained in the adjacent Colombian portion of the Sierra Perijá. The new material is somewhat the more robust and has a slightly different indument, but the deviation is not surprising in *Befaria*, of which the species are extremely variable. The original description may now be amplified as follows:

Glandular hairs of the branchlets and pedicels up to 2 mm in length (hairs of this type also present on both surfaces of leaves, especially along the costa beneath), the softer, canescent indument of the type specimen completely lacking in *Ginés* 1985; leaf-blades up to 22 mm long and 3 mm broad; inflorescence similarly terminal but comparatively elongate, the rachis up to 3.5 cm long, the pedicellary bracteoles about 3 mm long.

Tepuia speciosa A. C. Sm. in Contr. U. S. Nat. Herb. **29**: 336. 1950.

VENEZUELA: Bolívar: Mount Auyan-tepuí, alt. 2,100 m, *Cardona* 2659 (US).

The second collection of this very distinct species, from the type locality, agrees excellently with Cardona's earlier material (no. 257) upon which the species was based. Of considerable interest also are additional specimens from the type locality of two of the original species of the remarkable genus *Tepuia*, based upon earlier collections from Auyan-tepuí (cf. Camp in Brittonia **3**: 178–184, *fig. 4, 5*. 1939). These collections represent *T. tatei* Camp (*Cardona* 2667, US) and *T. venusta* Camp (*Cardona* 2666, US).

Pernettya purpurascens (H. B. K.) comb. nov. "*Gualtheria*" *purpurascens* H. B. K. Nov. Gen. & Sp. **3**: 282. 1818.

COLOMBIA: *Humboldt & Bonpland* (TYPE in herb. Paris; photo. of isotype in herb. Berlin, Chi. Nat. Hist. Mus. photo. no. 4759, in US, etc.); Cundinamarca: Páramo de Choachi, near Bogotá, alt. 3300–3500 m., *Pennell* 2218 (NY, US) (shrub on dry páramo; fruit black-purple); Páramo de Guasca, 8 km east of Guasca, alt. 3500–3600 m, *Fosberg* 21701 (US) (prostrate, occasional in open spots on ridges; lower surface of leaves purple; ripe fruit black).

Gaultheria purpurascens is apparently a very rare plant, and perhaps for this reason the fact that it is referable to *Pernettya* has been overlooked. The three specimens known to me are all in fruit and in this condition unmistakably represent *Pernettya*, the calyx-lobes remaining small and free from the mature fruit. The species is not accounted for in Sleumer's revision of *Pernettya* (in Notizbl. Bot. Gart. Berlin **12**: 626–655. 1935), and it appears not to have been redescribed in either genus. Its position in *Pernettya* is very distinct, the long, stiff, bristlelike hairs that cover both sides of the leaves and the distal parts of branches immediately distinguishing it; its relationship to the forms of *P. prostrata* (Cav.) Sleumer that occur in the Andes seems remote.

VACCINIACEAE[2]

Gaylussacia cardenasii, sp. nov.

Frutex ad 3 m altus, ramulis gracilibus subteretibus cinereis apices versus dense foliatis et copiose puberulo-tomentellis (pilis albidis ad 0.5 mm longis) mox glabratis; petiolis gracilibus canaliculatis 2–2.5 mm longis ut ramulis puberulis glabratisque; foliorum laminis subcoriaceis in sicco olivaceis oblongis, (2–) 2.5–4 cm longis, 0.8–1.2 cm latis, basi obtusis vel subacutis, apice obtusis vel rotundatis atque glandula crassiuscula prominente terminatis, margine leviter recurvatis obscure crenulatis vel subintegris, junioribus utrinque copiose luteo-glandulosis et praecipue marginem versus parce puberulis, maturis glabratis glandulis obscuris, costa supra subplana (in foliis maturis impressa) subtus elevata, nervis secundariis utrinsecus 4–6 subadscendentibus et rete venularum utrinque primo prominulis demum subimmersis; racemis axillaribus 8–12-floris basi bracteis circumdatis,

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[2] The genera of Vacciniaceae are discussed in the sequence proposed by Sleumer in Bot. Jahrb. **71**: 386–389. 1941.

bracteis imbricatis papyraceis margine breviciliolatis, extimis semiorbicularibus, intimis obovatis ad 6 mm longis, rhachi gracili tereti pilis albidis 0.1–0.2 mm longis copiose puberula ac etiam dispersim luteo-glandulosa, glandulis interdum brevi-stipitatis; bracteis sub floribus papyraceis oblongis vel obovato-ellipticis, 6–9 mm longis, 4–6 mm latis, saepe apiculatis, utrinque obscure puberulis etiam luteo-glandulosis; pedicellis gracilibus sub anthesi 2–4 mm longis ut rhachi puberulis et glandulosis supra medium bibracteolatis, bracteolis lineari-oblanceolatis 3–4 mm longis 0.5–1 mm latis pariter indutis; calyce sub anthesi 3–4 mm longo apice circiter 5 mm diametro, tubo breviter cupuliformi pilis patentibus 0.5–1 mm longis capitato-glandulosis copiose hispidulo etiam glandulis numerosis subsessilibus ornato, limbo campanulato-rotato dorso sessiliglanduloso intus glabro, margine puberulo-ciliolato etiam glandulis brevi-stipitatis copiose ornato, lobis 5 ovato-deltoideis obtusis 2–2.5 mm longis latisque; disco pulvinato centrum versus obscure puberulo; corolla submembranacea maturitate campanulata circiter 6 mm longa apice 6–7 mm diametro, utrinque glabra vel extus pilis paucis brevi-stipitatis glandulosis ornata, lobis 5 deltoideis obtusis circiter 3 mm longis latisque saepe recurvatis; staminibus 10 ad 3.8 mm longis, filamentis liberis ligulatis circiter 1.5 mm longis ubique adscendenti-albido-puberulis, antheris 2.5–2.7 mm longis, thecis circiter 1 mm longis basi obtusis, tubulis per rimas ovales introrsas dehiscentibus; stylo crasso tereti circiter 5 mm longo basim versus puberulo, stigmate minute peltato.

Bolivia: Santa Cruz: Samaipata, "El Fuerte," alt. 1700 m, November 1950, *M. Cárdenas* 4643 (US 2027184 type) (shrub 2–3 m high, on grassy slopes; flowers pinkish).

The species here described is not closely allied to the known Andean species of *Gaylussacia*, being very different from those recently described by Sleumer as *G. loxensis* and *G. peruviana* (in Bot. Jahrb. **71:** 384–385. 1941). It is more closely related to those few Brazilian species that have short, campanulate corollas and a glandular indument, perhaps especially to *G. rugosa* Cham. & Schlechtend., from which it differs in its narrower leaf-blades, which are subacute or obtuse at apex rather than prevailingly retuse. The new species, as compared with *G. rugosa*, has a shorter inflorescence and a different distribution of glandular hairs; in the Brazilian species such hairs are present on the branchlets, rachis, and pedicels as well as on the calyx, but in *G. cardenasii* the glands are very nearly sessile except on the calyx-tube.

Sphyrospermum haughtii, sp. nov.

Frutex gracilis, ramulis elongatis teretibus inconspicue flexuosis apices versus 0.6–0.8 mm diametro breviter villosis (pilis pallidis 0.5–1 mm longis) demum cinereis glabratisque; petiolis gracilibus subteretibus 0.5–1 mm longis ut ramulis pilosis et glabratis; laminis in sicco coriaceis ut videtur in vivo carnosis opacis, ovatis, (2–) 2.5–3 cm longis, (1.2–) 1.5–1.8 cm latis, basi rotundatis, apice gradatim acuminatis (apice ipso saepe 5 mm longo calloso-obtuso), margine integris incrassatis anguste recurvatis, utrinque primo inconspicue pallido-pilosis (pilis ad 0.5 mm longis) mox glabratis vel subtus pilos castaneos glandulosos minutos dispersim gerentibus, costa et nervis secundariis plerumque 4 basim versus orientibus obscuris immersis, venulis immersis; inflorescentia axillari 1- vel 2-flora quam foliis breviore, rhachi subnulla, bracteis sub floribus lanceolatis 0.7–1 mm longis parce villosis, pedicellis gracilibus teretibus sub anthesi 7–10 mm longis ut calyce copiose villoso-puberulis (pilis albidis 0.2–0.4 mm longis) infra medium bibracteolatis, bracteolis linearibus circiter 0.7 mm longis; calyce sub anthesi 4–5 mm longo et apice diametro, tubo turbinato 2.5–3 mm longo et lato basi acuto apice leviter contracto, limbo erecto-patente papyraceo intus glabro 5-lobato, lobis late deltoideis acutis 0.6–1 mm longis, sinubus rotundatis; disco annulari-pulvinato glabro; corolla carnosa urceolata sub anthesi circiter 6 mm longa et 4.5 mm diametro praeter lobos interdum puberulos ubique glabra, lobis 5 deltoideis acutis circiter 0.7 mm longis; staminibus 10 quam corolla paullo brevioribus alternatim leviter inaequalibus, filamentis ligulatis alternatim circiter 1 mm et 1.5 mm longis superne pilis circiter 0.5 mm longis pallido-villosulis, antheris 3.5–4 mm longis, thecis circiter 1.5 mm longis basi rotundatis, tubulis quam thecis longioribus gracillimis per rimas ovales circiter 0.5 mm longas dehiscentibus; stylo gracili corollam fere aequante; fructibus juvenilibus obovoideis et calycis limbo persistenter pilosis.

Ecuador: Bolívar: Road above Balzapamba, alt. 2,400 m, May 3, 1942, *O. Haught* 3302 (US 1708049 type) (rock plant, the shoots ascending or trailing, the leaves rather thick; flowers very pale yellow).

The new species is characterized by its thick, acuminate leaves, short-pedicellate flowers, uniformly villose-puberulent calyx, urceolate glabrous corolla, and stamens with very slender tubules. In general it seems most closely allied to *S. sodiroi* (Hoer.) A. C. Sm., but that species has somewhat smaller, obtuse to subacute leaves, the corolla cylindric, at least 9 mm long and copiously villose, and stamens with comparatively long filaments.

Sphyrospermum buesii, sp. nov.

Frutex forsan epiphyticus et dependens, ramulis elongatis gracilibus apices versus hispidulo-puberulis (pilis pallidis ad 1 mm longis) demum glabratis, ad nodos incrassatis; petiolis gracilibus subteretibus circiter 1.5 mm longis ut ramulis pilosis; laminis coriaceis ut videtur in vivo carnosis opacis, oblongo-lanceolatis, (2–) 2.5–3 cm longis, 0.8–1.2 cm latis, basi obtusis vel anguste rotundatis, apice gradatim acuminatis et calloso-obtusis, margine incrassatis et anguste recurvatis, utrinque parce pilosis (pilis pallidis ad 1 mm longis) mox glabratis, e basi 3- vel 5-nerviis, nervis et venulis immersis; inflorescentia axillari 1- vel 2-flora quam foliis breviore, basi bracteis paucis ovato-deltoideis acutis 1–2 mm longis parce hispidulis circumdata, rhachi subnulla, pedicellis gracilibus sub anthesi 4–7 mm longis mox glabratis; calyce sub anthesi circiter 6 mm longo et apice 4 mm diametro extus pilis pallidis 0.6–0.8 mm longis copiose tomentello, tubo ellipsoideo 2–3 mm longo 1.5–2 mm diametro, limbo suberecto tubum excedente papyraceo intus glabro profunde 4- vel 5-lobato, lobis lanceolatis 2–2.5 mm longis subacutis, sinubus acutis; disco annulari-pulvinato glabro; corolla tenuiter carnosa urceolata sub anthesi 7–8 mm longa et medium versus circiter 4 mm diametro, basi et apice valde contracta, superne pilis castaneis 0.1–0.3 mm longis parce glanduloso-pilosa, lobis 4 vel 5 oblongis subacutis circiter 1 mm longis; staminibus 8 vel 10 similibus longitudine corollam fere aequantibus glabris, filamentis gracilibus ligulatis circiter 3 mm longis, antheris circiter 3.5 mm longis, thecis 1.5–2 mm longis basi obtusis, tubulis gracilibus thecas subaequantibus per rimas elongatas 1 mm vel ultra longas dehiscentibus; stylo gracili corollam subaequante.

PERU: Cusco: Yanatín Palmacocha, Alturas de Chaco, Prov. Convención, alt. about 2700 m, August 15, 1928, *C. Bues* 2165 (US 1423528 TYPE) (collected in the "ceja de la montaña").

Although the relationship of this new species appears to be with *S. sodiroi* (Hoer.) A. C. Sm. and the above described *S. haughtii*, it is very distinct from both on the basis of its proportionately narrower leaves and its elongate calyx with lanceolate lobes and acute sinuses. It is further distinguished from *S. sodiroi* by its shorter, essentially glabrous corolla and its shorter filaments, and from *S. haughtii* by its shorter pedicels, slightly longer corolla and filaments, and short anther-tubules dehiscing by comparatively elongate clefts.

Killipiella stereophylla A. C. Sm. in Contr. U. S. Nat. Herb. **29:** 357. 1950.

COLOMBIA: Nariño: Río Nembi, *André* 3399 (K) (May 23, 1876; scandent; flowers whitish rose).

The second known collection of this recently described species comes from essentially the type locality, the Río Nembi being a small tributary of the Río Cuaiquer about 20 km west of Ricaurte, the locality of von Sneidern's type (no. 612). In floral characters the two specimens are nearly identical, but the leaf-blades of the André specimen are only 10–15 mm long by 3–6 mm broad, somewhat smaller than those of the type.

Notopora cardonae, sp. nov.

Frutex ad 2 m altus multiramosus, ramulis rigidis teretibus gracilibus purpureo-fuscis copiose pubescentibus (pilis albidis debilibus patentibus 0.5–1 mm longis) demum glabratis cinerascentibus lenticellatis; foliis confertis saepe subimbricatis, petiolis teretibus rugulosis 2–3 mm longis validis (circiter 1 mm diametro) ut ramulis juvenilibus pilosis (pilis 0.2–0.5 mm longis); foliorum laminis rigide coriaceis in sicco fusco-olivaceis, plus minusve orbicularibus, 1.2–2 cm longis latisque, basi rotundatis vel minute cordatis, apice rotundatis (apice ipso obscure calloso), margine valde recurvatis vel subrevolutis, supra ut petiolis molliter pilosis, subtus sparsius vel secus costam pilosis, demum interdum subglabratis, subtus immerso-glandulosis, inconspicue pinnatinerviis, costa supra subplana subtus leviter elevata, nervis secundariis utrinsecus 3–5 patentibus et rete venularum supra interdum inconspicue prominulis subtus planis vel immersis; inflorescentia axillari uniflora, rhachi subnulla; pedicellis teretibus validis, in sicco 0.7–1 mm diametro rugulosis, sub anthesi 3–5 mm longis, ut petiolis pilosis, basi bracteis pluribus imbricatis subcoriaceis deltoideis acutis ad 0.5 mm longis parce pilosis circumdatis, paullo supra medium bibracteolatis (bracteolis bracteis similibus 1–1.3 mm longis), cum calyce conspicue articulatis; calyce in sicco subcoriaceo, 5–5.5 mm longo, 4.5–5 mm apice diametro, extus ut pedicellis parce piloso mox glabrato, tubo cupuliformi circiter 2 mm longo ad sinus inconspicue 5-angulato, limbo campanulato quam tubo longiore margine pilis circiter 0.5 mm longis persistenter ciliato 5-lobato, lobis deltoideis acutis 1–1.5 mm longis, sinubus rotundatis; disco carnoso annulari-pulvinato glabro; corolla cylindrico-subclavata tenuiter carnosa sub anthesi 22–25 mm longa et supra medium 5–6 mm diametro, utrinque glabra, lobis 5 sub anthesi patentibus oblongo-deltoideis obtusis 2–3 mm longis; staminibus 10 longitudine corollam fere aequantibus glabris similibus, filamentis subcarnosis ligulatis 15–17 mm longis primo corollam adhaerentibus mox liberis, antheras dorso apice thecarum adnexis, antheris validis 5–6 mm longis, thecis granulatis 3.5–4 mm longis basi obtusis, tubulis quam thecis brevioribus erectis liberis amplis per rimas ovales dorsales 1.5–2 mm longas dehiscentibus; stylo gracili tereti corollam subaequante, stigmate minute peltato; fructibus juvenilibus ellipsoideis coriaceis levibus 5–6 mm longis calycis limbo persistente coronatis.

VENEZUELA: Bolívar: Summit of Mount Auyan-tepuí, Alto Caroní, alt. 2500 m, January 1949, *F. Cardona* 2656 (US 1997672 TYPE) (shrub 2 m high; corolla red).

The remarkable plant here described, another representative of the highly endemic flora of Mount Auyan-tepuí, does not at first glance suggest the supposedly monotypic genus *Notopora*, which has been extended in range but not in number of species since its proposal in 1876 (Hook. f. in Hook. Ic. Pl. **12**: 53. *pl. 1159*). However, the stamens with elongate filaments and short, dorsally dehiscing anthers permit of no other disposition of Cardona's plant. From *N. schomburgkii* Hook. f. our species is distinguished by many striking characters, most obviously by its small, coriaceous, suborbicular leaves with a sparser and quite different indument, its flowers lacking the persistent brown tomentum that covers both calyx and corolla in the older species, its comparatively small calyx, and its longer corolla and filaments.

Psammisia fissilis A. C. Sm. in Contr. U. S. Nat. Herb. **29**: 372. 1950.

PERU: San Martín: Almirante, Rioja [west of Moyobamba], *Sandeman*, August 1938 (K) (tall shrubby tree, growing in semi-shade in rainforest; corolla bright red).

This unnumbered Sandeman specimen represents the third known collection of the species and the first from Peru; the species was described on the basis of two Steyermark collections from the Province of Loja, Ecuador. The present specimen agrees excellently with the type (although the Ecuadorean specimens were indicated as lianas or epiphytic shrubs), except that its inflorescence-rachis is less than 1 cm long and bears only 4–6 flowers. In view of the similarity of foliage and floral parts, one cannot consider the compact inflorescence consequential.

Thibaudia pachyantha A. C. Sm. in Contr. U. S. Nat. Herb. **28**: 415. 1932.

COLOMBIA: Nariño: Barbacoas, between Corregimiento Santander (Buenavista) and Barbacoas (mouth of Río Telembí), alt. 200–840 m, *García-Barriga* 13121 (US).

The cited specimen represents the second collection of this very distinct species, which otherwise has been known only from the type, collected by Triana also in Nariño. The García-Barriga specimen is somewhat better preserved than the type and larger in some of its parts, having the lead-blades up to 18 cm long and 12 cm broad and gradually narrowed to an acuminate apex, while some of the pedicels are as long as 5.5 cm. The plant is said to be a small tree 3 m high, with red pedicels and corollas and yellowish-green calyces.

Plutarchia monantha, sp. nov.

Frutex parvus ubique plus minusve glaber, partibus novellis obscure puberulis, ramulis gracilibus apices versus circiter 2 mm diametro angulatis; stipulis intrapetiolaribus ovatis obtusis circiter 1.5 mm longis mox caducis; foliis parvis confertis, petiolis rugulosis canaliculatis 2–4 mm longis, laminis coriaceis in sicco olivaceis ovatis, (10–) 15–25 mm longis, (6–) 8–13 mm latis, basi truncato-rotundatis, apice calloso-acutis, margine integris incrassatis, juventute subtus interdum parce glanduloso-strigosis, obscure pinnatinerviis, costa supra leviter impressa subtus elevata, nervis secundariis utrinsecus circiter 3 immersis; floribus axillaribus solitariis subsessilibus basi bracteis pluribus imbricatis circumdatis, bracteis extimis parvis reniformibus interdum glanduloso-marginatis, intimis maximis papyraceis ellipticis ad 11 mm longis et 7 mm latis margine scariosis et parce ciliolatis, omnino caducis; pedicellis 0.5–1.5 mm longis primo minute puberulis ut videtur ebracteolatis; calyce sub anthesi circiter 11 mm longo et apice diametro, tubo coriaceo in sicco angulato basi truncato circiter 2.5 mm longo, limbo papyraceo erecto-patente fere ad basim 5-lobato, lobis lanceolatis acutis 7–8 mm longis, 2.5–3 mm latis margine glanduloso-ciliolatis; corolla carnosa ample cylindrica sub anthesi 21–23 mm longa et circiter 8 mm diametro, lobis 5 deltoideis acutis circiter 1.5 x 3 mm; staminibus 10 similibus longitudine corollam fere aequantibus, filamentis liberis ligulatis circiter 2.5 mm longis superne pilis ad 0.5 mm longis ciliolato-marginatis, antheris 17–18 mm longis, thecis 4–4.5 mm longis basi obtusis et incurvatis, tubulis quam thecis multo longioribus per rimas distales ad 2 mm longas dehiscentibus; stylo tereti corollam subaequante.

COLOMBIA: Caldas: Vicinity of Manizales, alt. about 3,300 m, January 1948, *Christopher Sandeman* 5694 (K TYPE) (subshrub, with coriaceous, bright green leaves; corolla cherry-red, greenish white at apex).

The beautiful little *Plutarchia* here described is closely related only to the recently proposed *P. minor* A. C. Sm. (in Contr. U. S. Nat. Herb. **29**: 380. 1950), differing in its ovate, larger, acute leaf-blades and its subsessile, somewhat larger flowers. From the only other species of this immediate alliance, *P. rigida* (Benth.) A. C. Sm., the new species is distinguished by its smaller leaves, solitary flowers, and smaller calyx-lobes, corolla, and stamens.

Cavendishia porphyrea A. C. Sm. in Contr. U. S. Nat. Herb. **29**: 383. 1950.

COLOMBIA: Nariño: Barbacoas, between Corregimiento Santander (Buenavista) and Barbacoas (mouth of Río Telembí), alt. 200–840 m, *García-Barriga* 13125 (US).

The cited specimen agrees excellently with the type and only other known specimen of this recently described species, from the Department of Cauca at low elevation. The Nariño material has slightly larger leaves than those described, the blades being up to 8 cm long and 2.5 cm broad, proportionately somewhat narrower than those of the type but with the same abrupt and slender acumen (up to 25 mm long). The flowers of the García-Barriga specimen are slightly smaller than those of the type, having the calyx about 6 mm long and the corolla about 30 mm long, with proportionately smaller stamens. These differences are no more than individual in an extremely well-marked species.

Cavendishia sandemanii, sp. nov.

Frutex, ramulis subteretibus glabris apices versus stramineis circiter 3 mm diametro inferne purpureo-cinereis; petiolis semiteretibus rugulosis 2–4 mm longis supra paullo puberulis; foliorum laminis coriaceis in sicco olivaceis, oblongo-ovatis, (3.5–) 5–6 cm longis, (2–) 2.5–3 cm latis, basi rotundatis vel subcordatis, apice obtusis vel obtuse brevi-cuspidatis, margine integris leviter recurvatis, supra glabris, subtus minute glanduloso-strigillosis mox glabratis, costa supra paullo impressa subtus elevata, nervis secundariis utrinsecus 2 vel 3 e basi vel paullo supra orientibus adscendentibus costa similibus, extimis saepe obscuris, rete venularum immerso; inflorescentia apices ramulorum versus axillari racemosa multiflora basi bracteis subcoriaceis semiorbicularibus dorso subpuberulis intimis ad 4 x 5 mm circumdata, rhachi gracili glabra (3–) 4–6.5 cm longa, bracteis sub floribus papyraceis glabris obovato-oblongis ad 25 mm longis et 12 mm latis; pedicellis gracilibus teretibus rugulosis sub anthesi et fructu 12–15 mm longis, superne inconspicue sessili-glandulosis, basim versus manifeste bibracteolatis, bracteolis papyraceis lineari-lanceolatis 5–6 mm longis, 0.7–1 mm latis, glandulas paucas marginales gerentibus; calyce sub anthesi circiter 5 mm longo et 7 mm apice diametro, tubo coriaceo cupuliformi 2–2.5 mm longo ruguloso glandulis pallidis dispersis sessilibus ornato, limbo subpatente papyraceo tubum subaequante glabro 5- vel 6-lobato, lobis late deltoideis acutis circiter 1 mm longis glandulas lineares subapicales gerentibus, sinubus rotundatis; corolla tenuiter carnosa cylindrica sub anthesi circiter 15 mm longa et 5 mm diametro extus pilis ad 0.5 mm longis albidis copiose puberula intus glabra, lobis 5 vel 6 oblongis obtusis 1–1.5 mm longis; staminibus 10 vel 12 longitudine subaequalibus circiter 14 mm longis, filamentis liberis ligulatis superne intus puberulis alternatim circiter 1.5 mm et 2 mm longis, antheris paullo inaequalibus, thecis 4–4.5 mm longis, tubulis 8–9 mm longis per rimas elongatas dehiscentibus; stylo tereti corollam subaequante; fructibus juvenilibus subglobosis ad 6 mm longis glabris, pedicellorum bracteolis subpersistentibus.

COLOMBIA: Boyacá or Santander: Between Paipa (Boyacá) and San Gil (Santander), alt. about 3,000 m, May 1948, *Christopher Sandeman* 6015 (K TYPE) (shrub, growing in full exposure in moist places; corolla bright cherry-red).

In foliage and fundamental floral characters the new species is very similar to *C. cordifolia* (H. B. K.) Hoer., but it seems to merit specific recognition because of its elongate racemes (the rachis in *C. cordifolia* being insignificant, only rarely approaching 3 cm in length) and its long, linear-lanceolate pedicellary bracteoles (those of *C. cordifolia* being usually 1–3 mm long and comparatively evanescent). The pedicels and calyces of *C. cordifolia* are usually copiously pilose at anthesis and frequently persistently so, its vegetative parts are often white-pilose, and its pedicels only rarely exceed 10 mm in length. The occasionally 6-merous flowers of the new species are probably not significant. *Cavendishia cordifolia* is now known from a great number of specimens from the Eastern Cordillera of Colombia and is quite homogeneous, so that the inclusion of the extreme form here described as *C. sandemanii* at present seems unwarranted.

Cavendishia rigidifolia A. C. Sm. in Contr. U. S. Nat. Herb. **28:** 500. 1932.

COLOMBIA: Antioquia: Medellín, Río Negro, alt. about 2,100 m, *Sandeman* 5660 (K) (tall straggling shrub, growing in full exposure and in semi-shade; corolla pink, tinged with white); Medellín, camino viejo al Alto de Santa Elena, alt. about 2,300 m, *Uribe Uribe* 2073 (US) (shrub; corolla red).

The second and third known collections of this rare species, like the type, were obtained in Antioquia; they agree with the type in all essential characters, but the leaves are slightly smaller (petioles sometimes only 3 mm long; leaf-blades toward apices of branchlets as small as 10 by 2 cm, but more often at least 13 by 2.5 cm, with the same proportions, texture, and venation as those of the type).

Orthaea ferreyrae, sp. nov.

Frutex ad 5 m altus, ramulis rectis subteretibus vel superne angulatis apices versus 1.5–3 mm diametro puberulis (pilis patentibus albidis ad 0.4 mm longis) vel glabris cinerascentibus; stipulis intrapetiolaribus interdum persistentibus lanceolatis 2–5 mm longis; petiolis semiteretibus vel canaliculatis rugulosis 3–5 mm longis ut ramulis puberulis vel glabris, foliorum laminis in sicco subcoriaceis fusco-olivaceis, lanceolatis, (5–) 7–11 cm longis, 1.5–3 cm latis, basi obtusis, superne ad apicem 1–2 cm longum mucronulatum gradatim angustatis, margine integris incrassatis saepe recurvatis, utrinque glabris vel subtus inconspicue glanduloso-strigosis vel secus costam breviter pilosis, costa supra impressa subtus prominente, nervis secundariis utrinsecus 2 vel 3 adscendentibus inconspicuis supra planis vel prominulis, intimis cum costa 5–20 mm interdum concurrentibus subtus paullo elevatis, aliis e basi orientibus interdum subimmersis, nervis tertiariis e costa paucis inconspicuis et rete venularum immersis vel supra subprominulis; inflorescentia axillari racemosa 10–20-flora (floribus sub anthesi paucioribus) basi bracteis mox caducis circumdata, rhachi (2–) 3–7 cm longa ut ramulis parce puberula vel glabra, bracteis sub floribus lanceolatis circiter 2 mm longis caducis; pedicellis sub anthesi 15–20 mm longis superne incrassatis basim versus bibracteolatis, bracteolis mox caducis, ut calyce parce puberulis vel glabris; calyce sub anthesi 5–7 mm longo et apice diametro, tubo leviter apophysato in sicco ruguloso 2–3 mm longo, limbo erecto-patente papyraceo quam tubo longiore margine glandulas inconspicuas sessiles interdum gerente 5-dentato, dentibus deltoideo-apiculatis haud 0.5–1 mm longis, sinubus rotundatis vel complanatis; corolla tenuiter carnosa glabra cylindrica sub anthesi 18–21 mm longa et circiter 5 mm diametro, superne contracta, lobis 5 oblongo-deltoideis obtusis 2–2.5 mm longis; staminibus 10 alternatim valde inaequalibus, filamentis membranaceis alternatim 3–4 mm et 5–8 mm longis inferne in tubum connatis, longioribus distaliter gracilibus et ciliolatis vel puberulis, antheris 4–6 mm longis, tubulis thecas subaequantibus per rimas ovales 1–2 mm longas apertas dehiscentibus; stylo tereti corollam subaequante, stigmate minute peltato.

PERU: Huánuco: Carpish, crest between Huánuco and Tingo María, alt. 2800–2900 m, February 6, 1950, *R. Ferreyra* 6709 (US 2057842 TYPE) (shrub about 1 m high, in evergreen woods; corolla red, the apex white); Loreto: Divisoria, Prov. de Coronel Portillo, alt. 1,500–1,600 m, *Ferreyra* 1671 (US) (shrub 2–5 m high, in tropical forest; corolla scarlet, white at apex); Junín: Huacapistana, alt. 1,700–1,800 m, *Sandeman*, June 1938 (K) (shrub in semishade on edge of rain-forest; corolla deep rose), *Sandeman* 4514 (K) (subshrub, in scrub on mountainside; corolla crimson), 4588 (K) (shrub on overhanging rock in gully, in semishade; corolla crimson); Agua Dulce, Prov. Tarma, alt. 2,000 m, *Woytkowski* 35482 (Ch, US) (shrub 4 m high, in forest; calyx red; corolla vermilion with white tip).

The cited specimens are not entirely identical, but there seems little doubt that they represent the same taxon, apparently localized in central Peru. The type has a fairly persistent indument on its branchlets, rachis, and pedicels, while the other specimens are essentially glabrous; *Ferreyra* 1671 has slightly smaller calyces than the other collections.

Orthaea ferreyrae is related to a group of three species of southern Peru and Bolivia, having flowers most similar to those of *O. pinnatinervia* Mansf., from which it differs in having its leaves with basally oriented, ascending secondaries, and in its elongate inflorescence, longer pedicels and calyx, more ample corolla, and stamens with much longer filaments and somewhat larger anthers. From *O. weberbaueri* Hoer., which it resembles in foliage, the new species differs in obvious floral characters, namely its longer pedicels, its calyx-limb without marginal thickenings and with rounded rather than acute sinuses, and its much larger stamens. As compared with *O. ignea* Sleumer, *O. ferreyrae* lacks the rufescent foliar indument and is further distinguished by its elongate inflorescence and larger flowers, especially as regards the pedicels, calyx, and filaments.

Satyria vargasii, sp. nov.

Frutex ad 2 m altus, ramulis subteretibus stramineis vel purpurascentibus apices versus 1–2.5 mm diametro et minute albido-puberulis demum glabratis; foliis pro genere parvis, petiolis subteretibus rugulosis 1–2 mm longis ut ramulis puberulis glabratisque, laminis in sicco subcoriaceis fusco-olivaceis glabris, ellipticis, 2–3 cm longis, 1.3–1.8 cm latis, basi rotundatis vel late obtusis, apice rotundatis, margine integris incrassatis leviter recurvatis, e basi 5- vel 7-nerviis, costa nervisque secundariis intimis adscendentibus supra prominulis subtus paullo elevatis, nervis secundariis inferioribus et rete venularum saepe immersis; inflorescentia 1- vel 2-flora basi bracteis paucis papyraceis deltoideis obtusis ad 1.5 mm longis ciliolatis caducis circumdata; pedicellis teretibus in sicco rugulosis sub anthesi ad 12 mm longis et calyce minute puberulis basim versus bibracteolatis, bracteolis lanceolatis acutis 1.5–2 mm longis; calyce sub anthesi circiter 4.5 mm longo et 5 mm apice diametro, tubo cupuliformi 1.5–2 mm longo, limbo papyraceo erecto-patente intus glabro profunde 5-lobato, lobis ovato-deltoideis apiculatis 2–2.5 mm longis, sinubus acutis; disco annulari-pulvinato glabro; corolla tenuiter carnosa cylindrica sub anthesi 10–12 mm longa et circiter 4 mm diametro extus minute puberula intus glabra, lobis 5 oblongis haud 1 mm longis; staminibus 10 leviter inaequalibus alternatim circiter 5.5 mm et 6 mm longis, filamentis membranaceis glabris in tubum circiter 2.5 mm longum connatis, antheris alternatim circiter 3.7 mm et 4.2 mm longis, thecis basi apiculatis incurvatis, tubulis longitudine thecas subaequantibus apice dilatatis per rimas ovales 1–1.5 mm longas dehiscentibus; stylo gracili tereti corollam subaequante.

PERU: Cusco: Prov. Paucartambo, between Sanamayo and Tambomayo, alt. 1360 m, May 4, 1947, *C. Vargas C.* 6493 (US 1997863 TYPE) (shrub about 2 m high, in open valley).

Although the plant here described is superficially suggestive of such small-leaved species of *Thibaudia* as *T. biflora* (Poepp. & Endl.) Hoer., its staminal characters make its assignment to *Satyria* imperative. Here, however, it has no close allies, being perhaps most nearly related to *S. polyantha* A. C. Sm., from which it is immediately distinguished by its much smaller leaves, its 1- or 2-flowered inflorescence, its conspicuously lobed calyx, and its comparatively large floral parts.

MYCOLOGY.—*Development of* Pythium debaryanum *on wet substratum.*

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In a recent paper (Drechsler, 1952) on swarm-spore development from oospores of *Pythium ultimum* Trow (1901) and *P. debaryanum* Hesse (1874) the two fungi were compared with respect to the morphology of their sexual reproductive apparatus as displayed in Petri plate cultures prepared with moderately firm maizemeal agar. Comparison in such cultures was deemed appropriate since both fungi are widely operative as causal agents of damping-off, root rot, and stem rot in many phanerogamic crop plants and consequently are most often encountered by plant pathologists, by whom pathogenic microorganisms have long been studied on agar media. As the discussion and illustrations previously devoted to *P. debaryanum* covered its morphology only in part, some additional aspects of development disclosed by that species on wet substratum are given attention herein. Besides encouraging zoospore formation free liquid water makes for longer antheridial branches and narrower antheridia, so that sexual reproductive apparatus developed under wet conditions has a characteristic rangy appearance. To investigators of the aquatic microflora, who mostly have continued to study oomycetes in submerged or irrigated material, the rangier reproductive habit may even nowadays be more familiar than the somewhat compact habit usual in unwet substrata. The modifications resulting from aquatic conditions often appear here and there in Petri plate cultures, owing to condensation of water within the covered dishes in quantities sufficient to form shallow pools or wet areas on the agar surface. Sometimes, indeed, when Petri plate cultures are stored during periods of hot weather in a refrigerator equipped with an efficient temperature-control device the agar becomes wetted so extensively that indications of zoospore formation may be found almost everywhere.

The same isolation that was used in preparing the illustrations of *Pythium debaryanum* in my earlier paper (Drechsler, 1952, figs. 7, 8) was used also in illustrating development of the species on irrigated slabs of maizemeal agar (Figs. 1–3). Another isolation, one obtained in May, 1922, from a softened pea (*Pisum sativum* L.) root taken near Madison, Wisconsin, was employed in illustrating development on irrigated slabs of Lima-bean agar (Figs. 4, 5). When they were tried out at different times in the greenhouse the two isolations showed moderate capabilities for the destruction of seedlings. In wound-inoculation experiments with plant products like cucumber (*Cucumis sativus* L.), squash (*Cucurbita pepo* L.) and watermelon (*Citrullus vulgaris* Schrad.) fruits they likewise showed effectiveness as agents of rapid decay in more mature fleshy vegetable tissue.

A mycelium of *Pythium debaryanum* actively growing in a Petri plate of maizemeal agar often displays a branching habit generally similar to that of my *P. anandrum* (Drechsler, 1939, fig. 12), in that its long axial hyphae are rather markedly distinguished from the relatively short, somewhat closely ramified lateral branches borne on them. The same branching habit is frequently recognizable also in *P. mamillatum* Meurs (1928) and *P. spinosum* Sawada (1927), whereas in *P. ultimum* growth is more promiscuous, with the lateral branches more often elongating indeterminately much like the hyphae from which they originated. Later, when mycelium of *P. debaryanum* is being emptied of contents to provide material for the production of sporangia (Fig. 1, A, t) and oogonia, successive stages in progressive evacuation of all hyphal components are marked by deposition, usually at comparatively short intervals, of successive convex retaining walls (Fig. 1, A, a-s). The tubular membrane of the empty filaments often evanesce more rapidly than the cross-walls, with the result that the matted empty hyphae on the surface of agar plate cultures 10 to 15 days old are frequently visible under the microscope only by their innumerable curved septa. Aging Petri plate cultures of *P. mamillatum* and *P. spinosum* similarly may show many crescentic cross-walls within tubular membranes that have largely vanished from sight. In *P. ultimum* the matted aerial mycelium affords only a rather meager display of curved septa.

Hesse, working with water cultures, described the zoosporangia of *Pythium debaryanum* as being formed terminally both on the lateral branches and on the main hyphae; and, indeed, terminal zoosporangia are produced abundantly on mycelium that has grown out from irrigated pieces of natural or artificial substratum. In agar plate cultures, however, zoosporangia of globose or prolate ellipsoidal shape are more often formed intercalarily (Fig. 2, A-E; Fig. 3, A-M; Fig. 4, E, a). Some sporangia develop close together on the same hypha (Fig. 2, F, a, b; Fig. 4, Y, a-c). Here and there remnants of protoplasm are gathered into cylindrical cells (Fig. 2, G, a, b; Fig. 3, N-P) which despite their unmodified shape are capable of serving as zoosporangia. When slabs excised from agar plate cultures 10 to 15 days old are placed in a shallow layer of water under cool conditions—I have used temperatures near 10° and 17° C.—some of the sporangia present will often in less than 1 or 2 hours put forth an evacuation tube (Fig. 2, H, t; Fig. 3, Q, t; Fig. 4, A, t) that soon forms a cap of dehiscense at its tip. This cap suddenly yields, and after the manner usual in the genus becomes inflated into a vesicle (Fig. 2, I, v) as it receives the protoplasmic materials discharged through the evacuation tube. Conversion of the protoplasm into laterally biciliate motile zoospores (Fig. 3, R, v, Fig. 4, B, v) ensues in about 20 minutes. Normally the zoospores escape and swim away when the vesicle wall collapses under their collective battering, but where the supply of water is inadequate the whole zoospore progeny (Fig. 2, J, a-r) may encyst without moving from its place of origin.

The evacuation tube in *Pythium debaryanum* may arise from any position on the sporangium (Fig. 2, H-S:t; Fig. 3, Q-X: t; Fig. 4, A-Y: t). Its observed length in my cultures has varied from 2μ (Fig. 4, V, t) to 135μ (Fig. 3, U, t). Instances in which the tube is shorter than 5μ or longer than 50μ are, however, decidedly infrequent. Examples more than 100μ long (Fig. 3, T, t; U, t) were discovered only by prolonged search in material displaying many thousands of empty sporangia in positions favorable for unambiguous observation. Hesse's statement that the evacuation tube is longer than the radius and shorter than the diameter of the sporangium bearing it sets forth a dimensional relation that assuredly is frequent in the species.

Although zoospore development often begins soon after a slab excised from an agar plate culture has been transferred to water, only a small proportion of all the sporangia present will commonly participate in such development at the start. Swarm-spore formation usually continues for several days as more and more of the remaining sporangia, in apparently haphazard sequence, produce evacuation tubes and discharge their contents. After 2 or 3 days considerable numbers of zoospores, some in encysted condition (Fig. 3, Y, a-e; Fig. 4, Z, a-g), others in an actively germinating state (Fig. 3, Y, f), may be found strewn about. Here and there imperfect cleavage of discharged masses of protoplasm results in grouped encysted bodies (Fig. 3, Z, a-d) frequently larger than normal zoospores and often of irregular shape.

The sexual reproductive apparatus of *Pythium debaryanum* formed on wet or submerged substratum, much like that formed on unwet agar, may be of either monoclinous (Fig. 1, B-L; Fig. 5, A-L) or diclinous (Fig. 1, M; Fig. 5, M-O) origin. Often in monoclinous reproductive units a solitary male branch arising at some little distance from the oogonium supplies a single terminal antheridium (Fig. 1, B-K; Fig. 5, A-F), though occasionally it supplies 2 antheridia (Fig. 5, G, a, b). Frequently 2 male branches arise from the oogonial hypha, each supplying an antheridium (Fig. 5, H, a, b). In some instances, however, where 2 antheridia are present, only one is borne on a branch (Fig. 5, I, a), the other being composed of a hyphal segment immediately adjacent to the oogonium (Fig. 5, I, b). Sometimes where 3 antheridia are present 2 of them (Fig. 5, J, a, b; Fig. 5, K, a, b) may be borne on separate branches arising from the oogonial hypha either on the same side (Fig. 5, J) or on opposite sides (Fig. 5, K) of an intercalary oogonium, while the third may consist of a cylindrical hyphal segment (Fig. 5, J, c; K, c) adjacent to the oogonium. Further variety in positional relationships of the male cells is provided now and then in instances where an oogonium is supplied with 4 antheridia, 2 of them (Fig. 5, L, a, b) perchance borne terminally on separate branches, a third consisting of a sessile pouchlike outgrowth (Fig. 5, L, c) arising in immediate proximity to the oogonium, and a fourth composed of a hyphal segment (Fig. 5, L. d) adjacent to the oogonium. Fertilization of an oogonium solely by an antheridium composed of an adjacent hyphal segment is observable only somewhat rarely in *P. debaryanum* (Fig. 1, L),

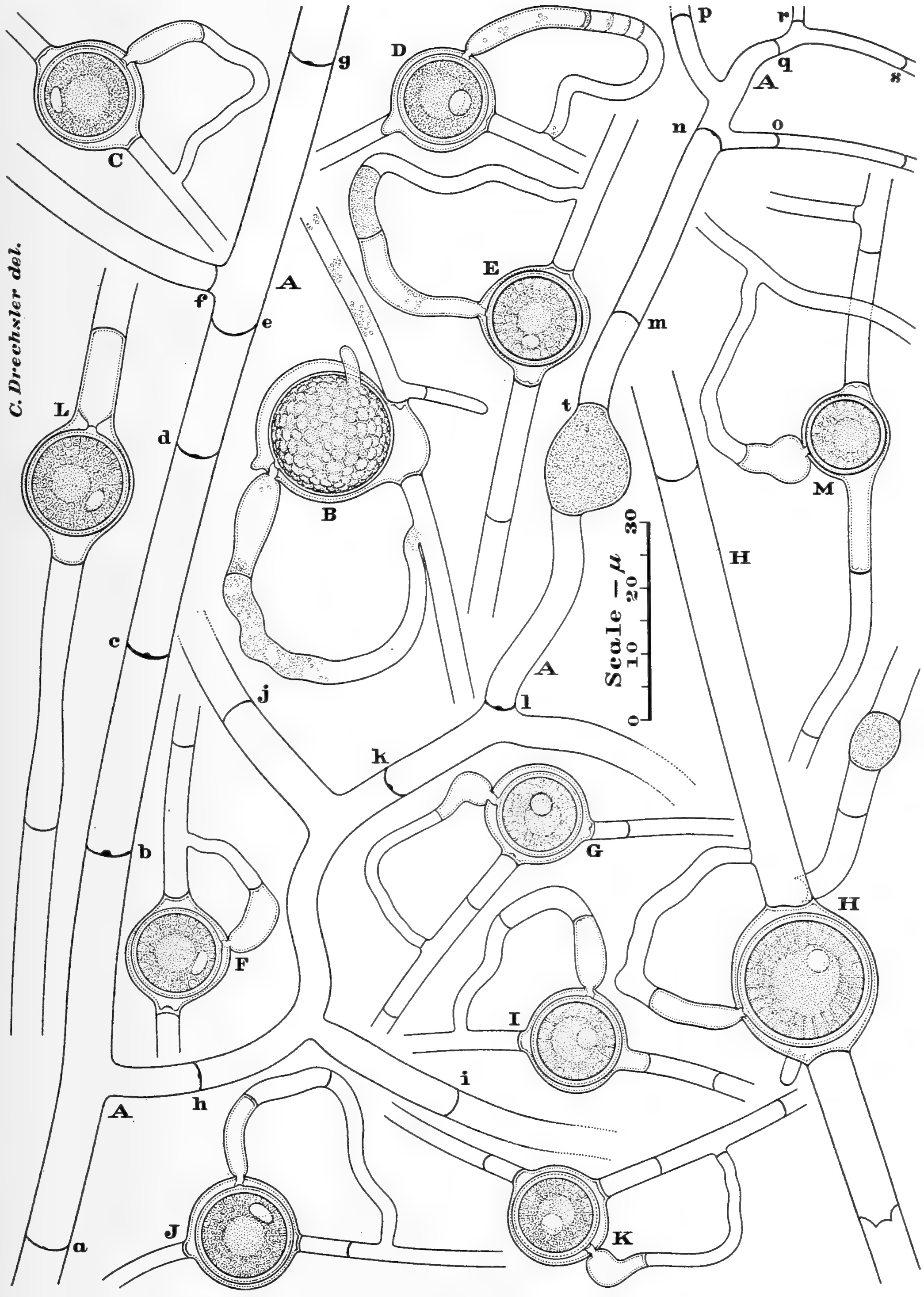


FIG. 1.—*Pythium debaryanum*, on wet maizemeal agar; × 1000. A, Empty mycelium with curved cross-walls, a-s, and a conidium, t. B-K, Units of monoclinous sexual apparatus, each with a single antheridium borne terminally on a branch. L, Monoclinous reproductive unit with antheridium consisting of a hyphal segment adjacent to oogonium. M, Diclinous reproductive unit. (Oospore young in B, nearly but not wholly mature in C, E-M.)

but is exceedingly frequent in *P. ultimum.* Indeed, such cylindrical antheridia as well as pouch-like sessile antheridia borne laterally in immediate proximity to oogonia are generally infrequent in *P. debaryanum,* and in many cultures are found only after some search.

Since for the most part the longer antheridial branches in monoclinous reproductive apparatus of *Pythium debaryanum* formed on wet substratum arise at no greater distance from the oogonium than the male branches in monoclinous apparatus formed in unwet agar cultures they necessarily follow more circuitous courses. In diclinous as in monoclinous reproductive apparatus the antheridia borne terminally on branches are commonly longer and narrower on wet substratum than in unwet agar cultures. A reciprocal relation between diclinous reproductive units comes to light in instances where two neighboring mycelial hypha (Fig. 5, O, a, b) each bear an oogonium (Fig. 5, O, c, d) that is fertilized by an antheridium (Fig. 5, O, e, f) borne on a branch given off by the other.

Hesse (1874, p. 25, line 2) described the oogonial envelope of *Pythium debaryanum* as being smooth and in his several illustrations pertaining to sexual reproduction the oogonium is shown without protuberances. It seems possible that only 4 individual oogonia are represented in these illustrations since 5 of his figures (Hesse, 1874, figs. 15–19) show such resemblances that they might well have been prepared at successively later stages from the same unit of sexual apparatus as his 2 figures (Hesse, 1874, figs. 13, 14) of earlier stages. In the fungus best conforming to Hesse's description smooth oogonia, as a rule, predominate strongly, yet if a considerable number of them are examined closely, scattered examples are usually found that bear one, two, or three protuberances (Fig. 1, B, H; Fig. 5, D, G, K). Mostly these protuberances are of cylindrical shape, and are broadly rounded at the tip like the fingers of a glove. Frequently they are only 2 or 3μ long, yet often, again, they measure 10 to 20μ in length. The shorter protuberances usually remain continuous with the oogonium, though the longer ones often become delimited by a basal septum.

This meager ornamentation might be disregarded but for the circumstance that isolations are often obtained which while closely resembling those with mostly smooth oogonia will rather commonly show digitations in sufficient numbers to be noticed even under cursory examination. The oogonia produced when such isolations are grown on Petri plates of maizemeal agar often vary markedly with respect to degree of ornamentation, some being devoid of protuberances, and others bearing 1 to 7 digitations in their upper and equatorial aspects. Throughout a culture the average number of protuberances exposed to view hardly ever seems much in excess of 3. In some cultures the same isolations appear very nearly smooth, with the oogonia there displaying, on the average, considerably less than one digitation apiece. Nevertheless the tendency toward development of protuberances in readily noticeable quantity apparently persists in these isolations over many years as an inherent character.

It is difficult to hold very strong convictions as to whether the isolations with this character represent merely a variant of *Pythium debaryanum* or a separate species. In the monographs of Matthews (1931) and Middleton (1943) *P. irregulare* Buisman (1927) is treated as a separate species with a circumscription that would evidently admit the noticeably digitate isolations under discussion and would exclude the nearly smooth isolations herein considered referable to *P. debaryanum.* This circumscription may not be strictly in agreement with the morphology of Buisman's fungus. Through the Centraal Bureau voor Schimmelcultures a culture of *P. irregulare* given by Buisman was supplied to me a few years after the species had been described. When the culture was transferred to maizemeal agar and Lima-bean agar the resulting sexual reproductive apparatus (Fig. 6, A-I) displayed few oogonial protuberances (Fig. 6, C, D), the degree of ornamentation observed not exceeding that usual in the relatively smooth isolations assigned to *P. debaryanum.* In the very numerous monoclinous reproductive units the antheridium was commonly borne on a branch arising some distance from the oogonium (Fig. 6, A-F). Where 2 antheridia were present in monoclinous units each was most frequently borne on a separate branch (Fig. 6, G, a, b), though in occasional instances one was borne on a branch (Fig. 6, H, a) while the other developed from a segment (Fig. 6, H, b) immediately adjacent to the oogonium. Buisman stated in her account that she never had seen hypogynal antheridia, yet after some little search in subcultures of her fungus a monoclinous reproductive unit was found in which the oogo-

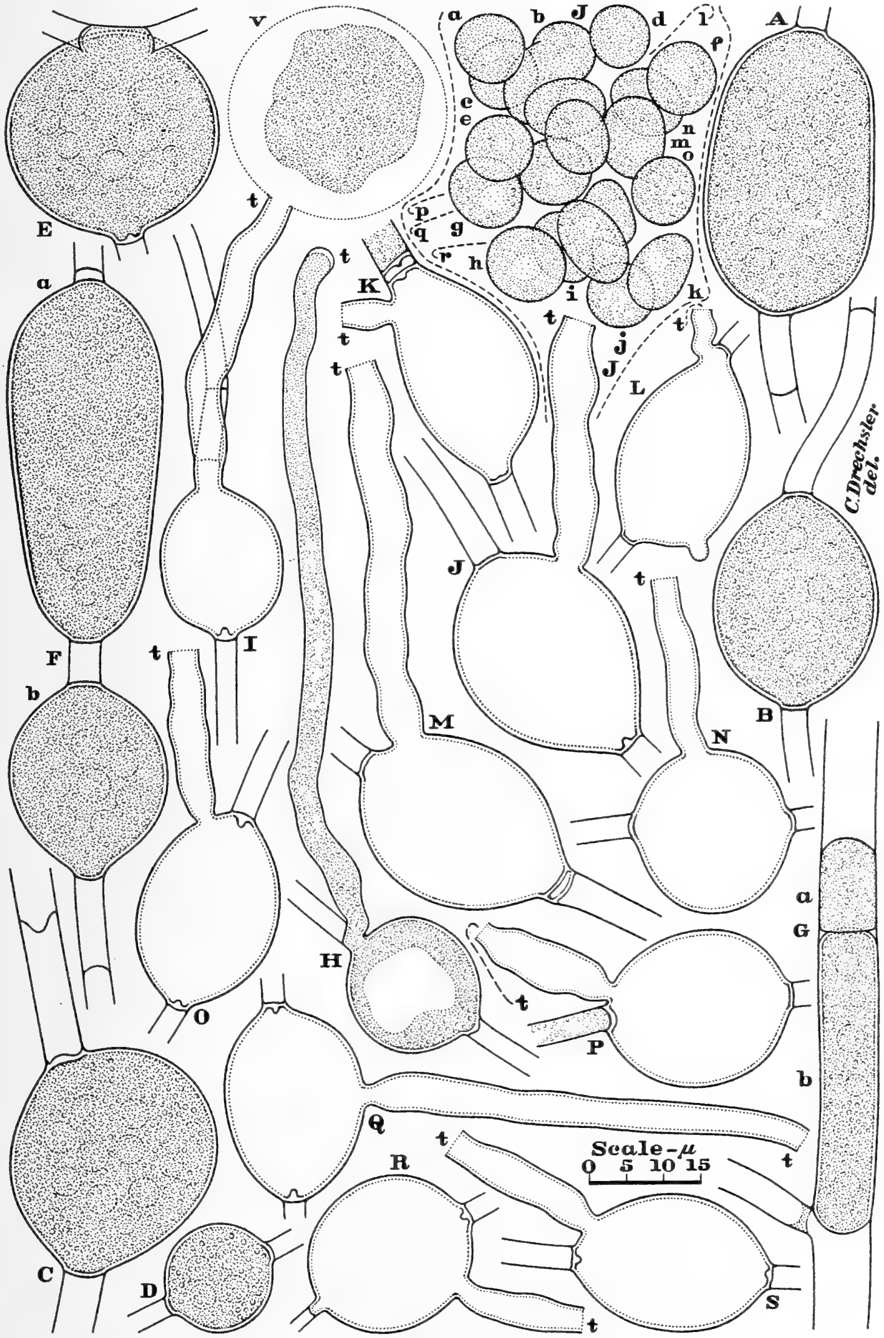


FIG. 2.—Asexual reproductive apparatus of *Pythium debaryanum* as found produced on wet maizemeal agar, drawn with the aid of a camera lucida at a uniform magnification; × 1000 throughout. A-E Intercalary zoosporangia. F, Two zoosporangia, a and b, formed near together. G, Two zoosporangia, a and b, formed in a wide hypha from remnants of protoplasm. H, Zoosporangium with unusually long evacuation tube, t, surmounted by hyaline cap. I, Newly discharged zoosporangium showing evacuation tube, t, with vesicle, v, at its tip. J, Discharged zoosporangium with its progeny of zoospores, a-r, encysted near mouth of its evacuation tube, t. K-S, Empty zoosporangia, each with its evacuation tube, t.

nium had been fertilized by 2 antheridia formed in immediate proximity to it, one consisting of an adjacent hyphal segment (Fig. 6, I, a), while the other, of pouch-like shape (Fig. 6, I, b), was sessile on the oogonial hypha.

Although Buisman distinguished *Pythium irregulare* from *P. debaryanum* mainly by the protuberances found on its oogonia, the 8 oogonia figured by her (Buisman, 1927, figs. 9, 10) show in all scarcely a dozen protrusions, and of these only 5 would seem of the digitate type. In some of her specimens the departures from a globose or ellipsoidal shape appear as if they might be attributable to collapse of portions of the oogonial envelope. Such collapse is considerably more pronounced in *P. debaryanum* than in *P. ultimum* since the oogonial envelope is noticeably thinner in the former species than in the latter, and consequently is more easily deformed either through mechanical disturbance or through loss of water. On the surface of agar cultures, where both *P. debaryanum* and *P. ultimum* often give rise to sexual apparatus most abundantly, the oogonial envelopes in mature reproductive units of *P. debaryanum* commonly show very marked deformation from collapse. As Buisman (1927, p. 10) apparently used no really efficient method for removing bacteria from her cultures it seems probable, besides, that at times the oogonia of her *P. irregulare* may have developed some of the promiscuous malformations often resulting from excessive bacterial contamination.

Buisman gave no descriptive details concerning either the three isolations she dealt with under the binomial *Pythium debaryanum* or the one isolation she identified as *P. debaryanum* var. *pelargonii* Braun. A statement given in her discussion of *P. irregulare* and reading "The antheridia are usually of the same type as those of *P. debaryanum*, but I never saw hypogynal antheridia" implies in its use of the adversative "but" that she recognized hypogynal antheridia as occurring in *P. debaryanum*, and thereby suggests that perhaps she applied Hesse's binomial to the species herein treated as *P. ultimum*. Such application, approximately, was urged some years later by Van Luijk (1934) in his proposal to adopt for *P. debaryanum* the circumscription set forth in De Bary's (1881a, 1881b) publications. Van Luijk believed this circumscription, which he intimated was supported by Butler, had governed usage until 1927 with complete satisfaction. He held that several faults in Hesse's paper discredited the original account of *P. debaryanum* so seriously that by itself it could not be regarded as providing a valid description. According to Van Luijk the faults in Hesse's account were rectified by De Bary in a characterization accurately portraying a fungus that can be found any day. In view of the imputed corrections the authorship of the species was broadened, so that the familiar binomial appeared as *P. debaryanum* Hesse em. De Bary.

Van Luijk regarded parasitism and the scope of asexual reproduction with respect to the presence or absence of zoospore development as being of no moment in distinguishing species; and he held it doubtful whether the differences in the antheridia of *Pythium debaryanum* and *P. ultimum* were sufficient to separate these two fungi. These views are largely contrary to my observations on the parasites under discussion. In my collection of cultures sameness or otherness has as a rule been indicated reliably by the capability of newly formed globose asexual reproductive bodies to produce zoospores and by the positional relation of the antheridium or antheridial branch in monoclinous sexual apparatus. The two features are most helpful, besides, in interpreting some of the early literature on the species sharing the particular kind of parasitism here in question, including the pertinent descriptive writings of Hesse, De Bary, and Trow.

These writings were all based on fungi obtained from seedlings that had succumbed to damping-off. Although this serious disease affects seedlings of many phanerogamic crop plants and is caused in rather considerable measure by species of *Pythium* the number of species effective enough in its causation to invite notice are few. In our middle and northern latitudes, where conditions of temperature and moisture during spring and early summer should not differ greatly from those in Alsace and Great Britain, the two species herein treated as *P. ultimum* and *P. debaryanum*, together with the somewhat digitate form treated by Matthews and Middleton as *P. irregulare*, are virtually the only damping-off parasites found which like the fungi described by Hesse, De Bary, and Trow give rise to relatively smooth oogonia and subglobose zoosporangia or conidia. Through this fortunate circumstance the few species mentioned are indicated rather definitely as the ones with which the writings of Hesse, De Bary, and Trow were

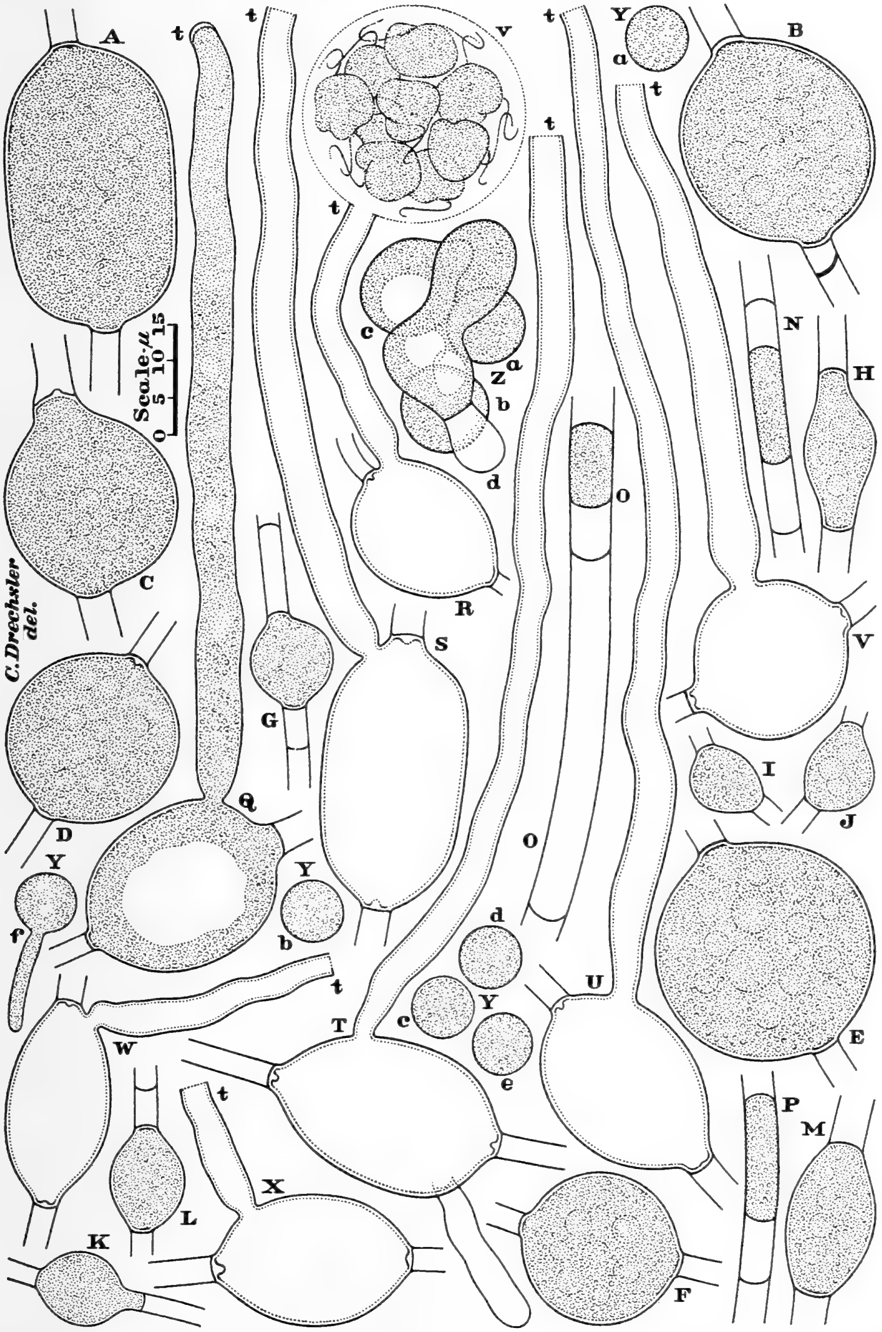


Fig. 3.—Asexual reproductive apparatus of *Pythium debaryanum* as found produced on wet maize-meal agar, drawn with the aid of a camera lucida at a uniform magnification; × 1000 throughout. A-M, Intercalary zoosporangia of various sizes and of globose or ellipsoidal shape. N-P, Small cylindrical zoosporangia formed in hyphae from remnants of protoplasm. Q, Zoosporangium with unusually long evacuation tube, t, surmounted by hyaline cap. R, Zoosporangium showing an evacuation tube, t, with a vesicle containing zoospores. S-V, Empty zoosporangia, each with an exceptionally long evacuation tube, t. W, X, Empty zoosporangia, each with an evacuation tube, t, of ordinary length. Y, Six encysted zoospores, a-f, of which one, f, is germinating. Z, Group of 4 encysted masses of protoplasm, a-d, resulting from frustrated development in discharged sporangial contents.

for the most part concerned. Thus De Bary's firsthand account of the damping-off fungus he considered to be *P. debaryanum* can be safely understood as relating unambiguously to a species found operating very widely and destructively as a causal agent of damping-off—to the species herein termed *P. ultimum*—though the morphology it sets forth would apply almost equally well to a closely related congeneric species, *P. paroecandrum* Drechsler (1940), which so far has come to light only as a cause of root rot and rootlet-tip discoloration. In Hesse's original and earlier description of *P. debaryanum* is set forth recognizably another parasitic species scarcely less widespread and efficient in the causation of damping-off than the one which De Bary presented under the same binomial. The differences whereby present-day isolations can be separated are detectable in the writings of the two pioneer investigators. Isolations in which very frequently the relatively smooth oogonium is fertilized by an antheridium borne terminally on a branch arising from the oogonial hypha at a distance from the oogonium about equal to the oogonial diameter—the relation of parts depicted by Hesse—will readily produce zoospores from zoosporangia of mycelial origin. On the other hand, damping-off isolations in which the oogonium is commonly fertilized by an antheridium consisting of an adjacent hyphal segment or of a lateral pouch-like cell arising in immediate proximity to the oogonium—the positional relationships most frequent in De Bary's illustrations—are decidedly reluctant to produce zoospores from conidia of mycelial origin, and yet will form them rather consistently from germinating after-ripened oospores or from sporangia borne on germ hyphae extended by after-ripened oospores. It is hardly surprising that De Bary, though a master of unsurpassed proficiency, found zoospores to be produced sparingly, whereas Hesse with only the limited experience of a student would seem to have obtained zoospores abundantly during the first few weeks he worked with his fungus. Van Luijk's success in obtaining zoospores from the isolations he referred to *P. debaryanum* Hesse em. De Bary may have been due primarily to his use of material from an old dried-up pure culture, for in such a culture the oospores present would ordinarily have had ample time to undergo the changes of after-ripening. If, as seems probable, the isolations were referable to *P. ultimum* they need not have been of exceptional reproductive behavior like the cultures that Ark and Middleton (1949) observed giving rise to zoospores from ordinary conidia.

In his text Hesse gave no measurements for the hyphae and reproductive bodies of *Pythium debaryanum*. Apparently he relied entirely on his illustrations to convey metric information. Unfortunately, at the magnifications given in the legends his figures show excessive approximate values for all dimensions: 13μ for width of a main mycelial filament; 45μ for diameter of zoosporangium; 20 to 23μ for diameter of encysted zoospores; 75μ and 50μ for length and width, respectively, of an intercalary conidium; 45 to 48μ for diameter of oogonium; 37μ and 10μ for length and width, respectively, of an antheridium; and 37μ for diameter of oospore. Since in any of the damping-off species—and the damping-off species are among the coarsest members of the genus—13μ is about twice the usual width of an elongating axial hypha a few hundred microns from its tip, the actual magnification would seem about twice that given in the legend. Indeed, if the magnifications given in all the legends were doubled the smaller dimensional values then derived from the figures would be in tolerably good agreement with the usual measurements for either of the damping-off fungi under discussion, which except for differences in thickness of oospore wall and in length of monoclinous antheridial branches are, in general, of nearly equal size. How the error might have come about is conjectural. It may perhaps be no mere coincidence that on the two folded plates of the published dissertation Hesse's figures occupy rectangular areas about twice the width of the printed pages. Should the procedure for making lithographs 80 years ago have readily permitted reproduction of illustrations at reduced sizes the magnifications appearing in the legends might have been given in the expectation that the plates would be adjusted to the width of the page. In any case, the error, though most unfortunate in the original account of a species which with respect to its binomial has become one of the most familiar of all fungi, is so very obvious that it should not occasion any serious misunderstanding as to what damping-off parasite was the main subject of Hesse's description.

In sexual apparatus of *Pythium debaryanum* produced on wet or unwet agar substratum the antheridia borne terminally on branches are

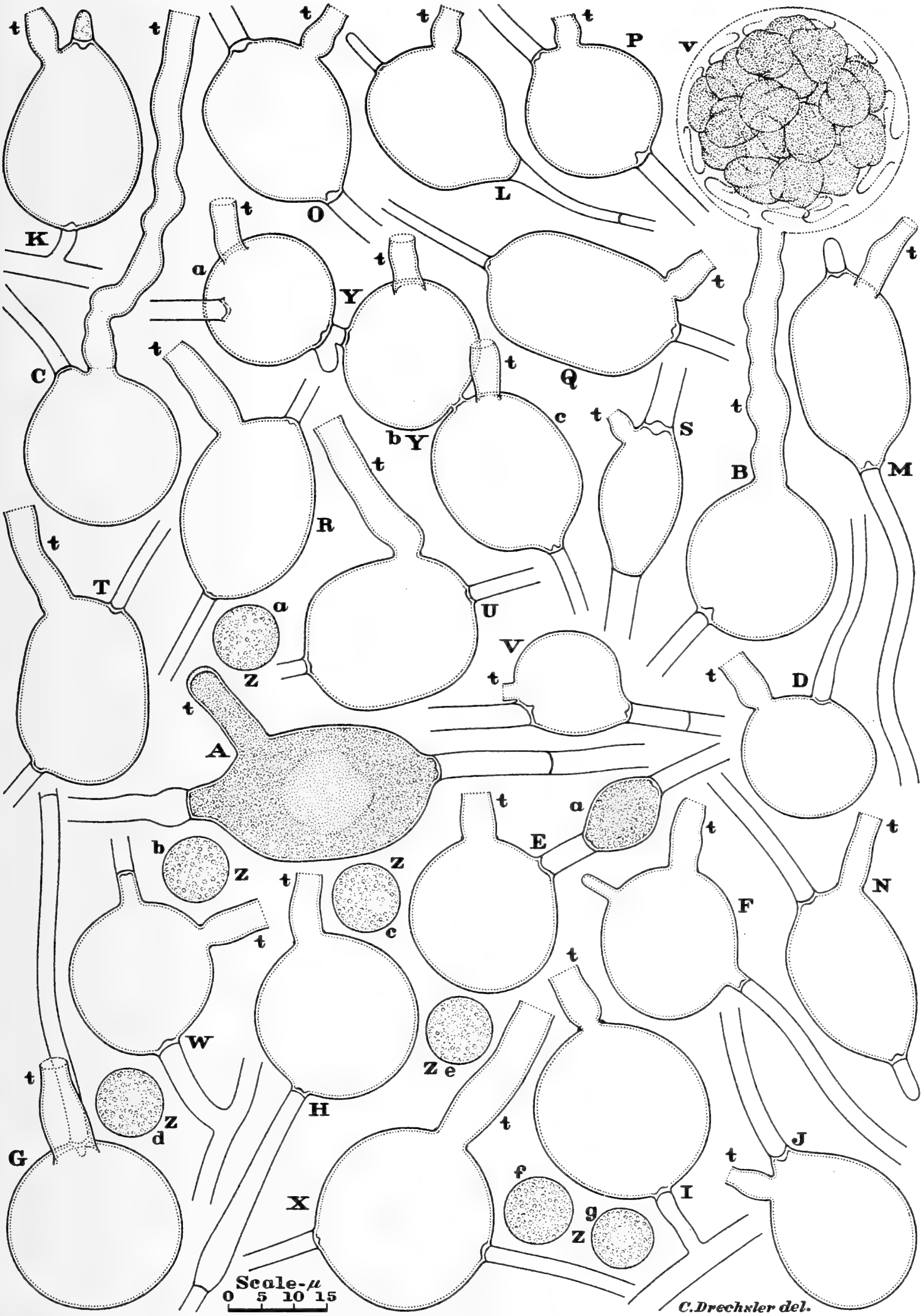


FIG. 4.—*Pythium debaryanum*, on moist Lima-bean agar; × 1000. A, Sporangium shortly before discharge. B, Sporangium with active zoospores in vesicle, v. C-J, Empty terminal sporangia. E, a, K-X, Empty intercalary sporangia. Y Three empty sporangia, a-c, close together. Z, Encysted zoospores, a-g. (A-Y: t, evacuation tube.)

rather consistently applied to the oogonium by their tips. However in sexual apparatus formed on extramatrical submerged mycelium, terminally borne male cells are often observable in more varied postures. Postural relations infrequent in agar cultures are shown in the illustrations not only of early workers like Hesse (1874) and Sadebeck (1875), who had only submersed material available for study, but also of later workers who have studied such material from preference. Thus, several of the figures of *P. irregulare* given by Matthews (1931, pl. 24, fig. 4; pl. 25, figs. 1, 3, 9) show antheridia applied laterally, and in at least two instances the male cell seems intimately in contact with the oogonium throughout its length (Matthews 1931, pl. 25, fig. 3, upper; fig. 9). In the few figures of sexual reproductive apparatus given by Hesse the antheridium is shown applied laterally, though the area of contact is rather well forward and of either small or only moderate extent. Hesse's text does not mention what portion of the antheridium makes contact with the oogonium, his most directly relevant phrases (sich dieser innig anschmiegt; das Anlegen des Pollinodiums; lagert sich an die Membran; dem Momente ihres Anlegens; durch Anlegen an die Membran des Oogoniums) not specifying directly either lateral or apical application, even if the word "anschmiegt" might connote rather extensive contact.

Sadebeck (1875, p. 124) in discussing sexual development in his *Pythium equiseti* stated that the antheridium is most often applied by its tip, that sometimes it becomes attached laterally to the oogonium, that very often it enwraps the oogonium, and that therefore the fertilization tube is extended either apically or laterally. In one of the figures given by Sadebeck (1875, pl. 4, fig. 3) a longitudinally applied antheridium is shown extending a lateral fertilization tube into the oogonium. In another figure of Sadebeck's, in which are shown two connected monoclinous reproductive units, the antheridium in one unit (Sadebeck, 1875, pl. 3, fig. 8, right) is narrowly applied to the oogonium with its tip, while the antheridium in the other unit (Sadebeck, 1875, pl. 3, fig. 8, left), is applied lengthwise, so that it enwraps the oogonium closely and rather extensively. The circuitous male branch in the former unit arises from the oogonial stalk at a distance from the oogonium about equal to the width of that organ. The male branch in the latter unit arises from the same hypha as the oogonial stalk, its origin being separated from the oogonium by hyphal elements having a combined length approximately equal to twice the oogonial diameter. None of Sadebeck's illustrations show any antheridium formed in immediate proximity to the oogonium, and in his text the antheridia in monoclinous units are, with regard to their hyphal relations, discussed only as being borne terminally on branches. As might be expected from the arrangement of its monoclinous sexual apparatus the fungus several times gave rise to zoospores following transfer of infected *Equisetum* prothallia to water. Since infected prothallia always disintegrated completely without leaving any visible residue, the host substratum used by Sadebeck for swarm-spore production must have been rather newly invaded, and thus presumably should not have contained any after-ripened oospores.

Because of its ready parasitism on many host plants De Bary considered it likely that his fungus might have been observed by other workers besides Hesse. He stated that the description of *Pythium equiseti* left scarcely any doubt that Sadebeck's fungus was identical with the one he and Hesse had studied. All doubt as to the presumed identity was dispelled for him when some healthy *Equisetum* prothallia, after being inoculated with his fungus, were destroyed "murderously" in a few days. Without the advantages provided in collections of pure cultures—advantages accruing from opportunity not only to examine isolations wholly free of alien organisms but also to compare with respect to morphology, development, and pathogenicity isolations obtained from different host plants, in different regions, and at different times—it is not surprising that De Bary failed to uncover the correlated differences in antheridial morphology and zoospore production whereby the damping-off parasite figured by him is distinguished from the fungus corresponding better to the descriptions and illustrations of Hesse and Sadebeck. The latter fungus may well have been present in some of De Bary's material, since he mentioned (De Bary, 1881 b, p. 526) that in some cultures zoosporangia were formed in relatively large numbers, intermixed with resting conidia produced at the same time and under apparently similar conditions. Besides, unless he had seen Hesse's species now and then in his own material it appears unlikely that he would so readily have noted in the description and figures of *P. equiseti*

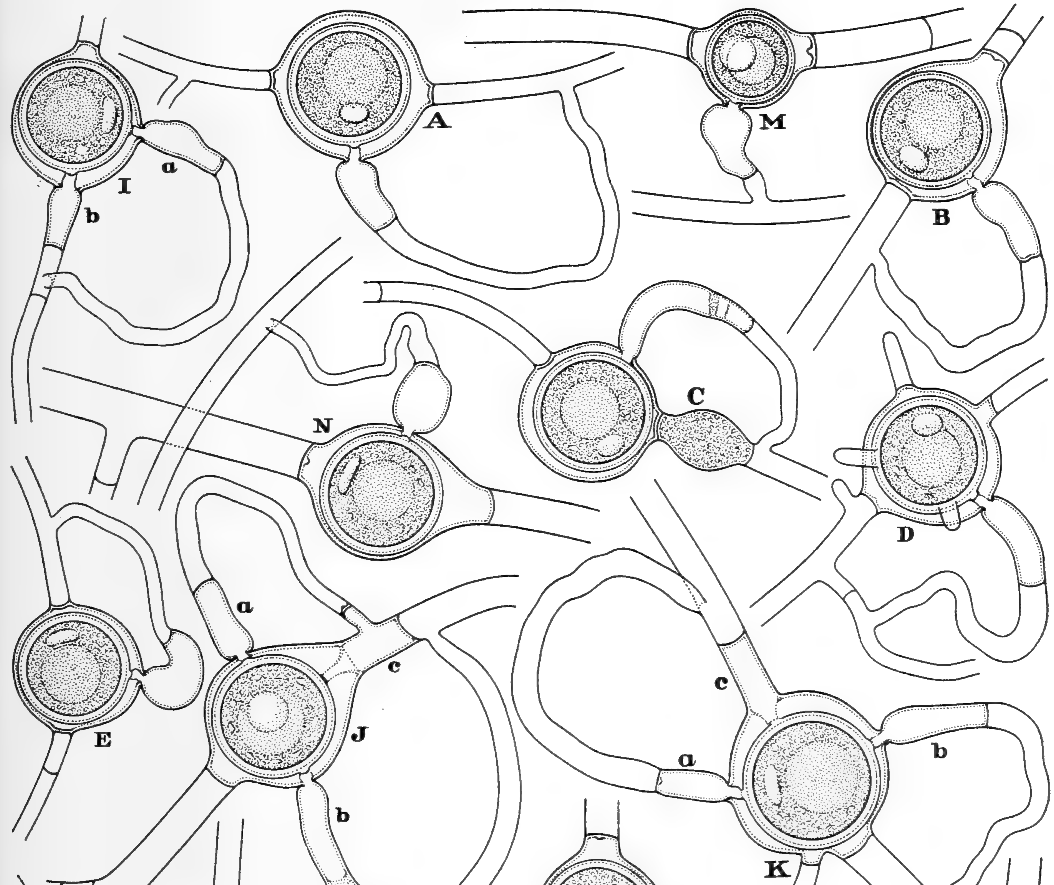


FIG. 5.—Mature sexual reproductive apparatus of *Pythium debaryanum* formed on moist Lima-bean agar; × 1000. A-F, Monoclinous units with single antheridia. G-I, Monoclinous units with 2 antheridia, a and b. J, K, Monoclinous units with 3 antheridia, a-c. L, Monoclinous unit with 4 antheridia, a-d. M, N, Diclinous units. O, Two connected diclinous units: a, b, parent hyphae; c, d, oogonia; e, f, antheridia.

any very persuasive similarity to the damping-off parasite depicted in his illustrations. His ready acceptance of Sadebeck's account would seem to imply that lateral fertilization tubes and laterally applied antheridia—even clasping antheridia—were not regarded by him as features incongruous with the morphology of *P. debaryanum*. It appears probable therefore that De Bary considered the treatment of antheridial morphology in Hesse's dissertation less as being wrong and requiring correction than as being insufficient and requiring amplification. Unhappily the amplification he provided would seem to have been derived for the most part, if not wholly, from a closely related species with similar parasitic tendencies.

Corroboration of Hesse's illustrations showing laterally applied antheridia and lateral fertilization tubes has come mainly from studies carried out on submerged material in water cultures. The positional instability usual in such cultures and the ease with which the more delicate submerged parts may be pushed out of place or pressed out of shape are not to be disregarded.

In Butler's (1907) monograph the treatment of the sexual reproductive stage in *Pythium debaryanum* conforms closely to De Bary's account. Butler's relevant firsthand observations then were limited to material obtained by causing cress seedlings to damp off at Freiburg im Breisgau, Germany. Although he found conidia and oospores produced abundantly, he saw no sporangia. His failure to obtain zoospores, together with his description of antheridia in the species as "from the same or another hypha as the oogonium, often formed close below the latter, and not seldom hypogynal," suggests strongly that the Freiburg fungus was the same as the one figured by De Bary.

A later paper published by Butler (1913) on *Pythium debaryanum* presents a firsthand account of a conspicuously different fungus he found at Pusa, India, in the caruncle of castor (*Ricinus communis* L.) seed that after being sown in pots of unsterilized soil had failed to germinate. In this fungus Butler did not observe any antheridia that consisted individually of a cylindrical hyphal segment adjacent to the oogonium. Often the antheridium was borne terminally on a branch arising from the oogonial hypha at some distance from the oogonium, the distance in six monoclinous reproductive units pictured (Butler 1913, figs. 1–4) ranging from about 10μ to 60μ. Above the junction of the two sexual stalks the female stalk was often longer than the male stalk and consequently was often curved. The resulting postural relation manifestly was the reverse of that shown in the sexual reproductive unit figured by Hesse, where the

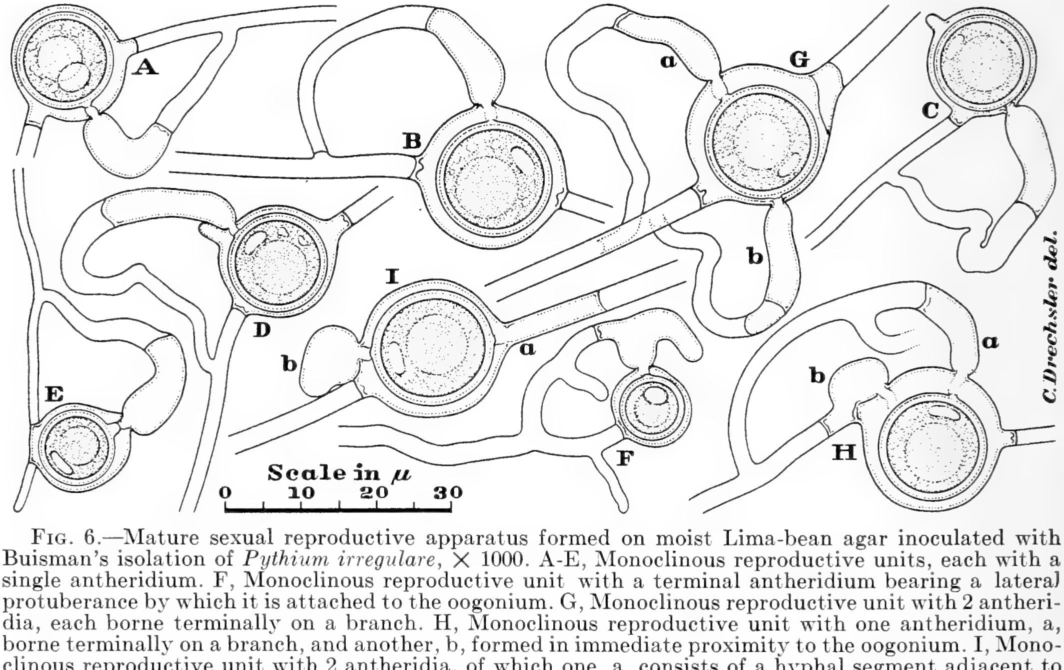


FIG. 6.—Mature sexual reproductive apparatus formed on moist Lima-bean agar inoculated with Buisman's isolation of *Pythium irregulare*, × 1000. A-E, Monoclinous reproductive units, each with a single antheridium. F, Monoclinous reproductive unit with a terminal antheridium bearing a lateral protuberance by which it is attached to the oogonium. G, Monoclinous reproductive unit with 2 antheridia, each borne terminally on a branch. H, Monoclinous reproductive unit with one antheridium, a, borne terminally on a branch, and another, b, formed in immediate proximity to the oogonium. I, Monoclinous reproductive unit with 2 antheridia, of which one, a, consists of a hyphal segment adjacent to the oogonium, while the other, b, is laterally sessile in immediate proximity to the oogonium.

straight oogonial stalk is shorter than the longer curving antheridial branch; and assuredly was the reverse of the postural relation most usual in monoclinous reproductive apparatus of the damping-off parasite herein treated under Hesse's binomial. Similar curvature of the oogonial stalk is found rather often in cultures of *P. butleri* Subr. and *P. aphanidermatum* (Eds.) Fitzp. (= *P. deliense* Meurs), and is conspicuous in Butler's (1907, pl. 2, figs. 3, 5, 6) illustrations of his *P. indigoferae*. Although the text contains no comment on the shape of the antheridium, all eight of the antheridia figured show a distinctive outward form in that they consist of a somewhat enlarged clavate terminal part together with a lateral protrusion by which they are united to the oogonium. Antheridia of approximately such design are found somewhat infrequently in *P. debaryanum* (Fig. 6, F) but are very numerous in *P. butleri* and *P. aphanidermatum*. It is not known whether the curious resemblance between the Indian fungus and *P. aphanidermatum* with respect to the make-up of their sexual apparatus may have had some influence in leading Jochems (1927) to identify provisionally as *P. debaryanum* the stem-burn parasite that Meurs (1934) later described under the binomial *P. deliense*. Apart from its production of zoospores from globose rather than from lobulate zoosporangia the Indian fungus with its relatively delicate mycelium appears clearly alien to Hesse's damping-off parasite, as well as to the other widely distributed damping-off parasite herein discussed, which after being set forth firsthand by De Bary was not described under a separate binomial of unambiguous application until Trow (1901) presented it somewhat mistakenly (Drechsler, 1935) as a new saprophytic species, *P. ultimum*. No species corresponding to the firsthand description and illustrations given by Butler has ever come to light among the cultures I have isolated from diseased plants and other materials. Since the Indian fungus was found in a locality where as high a temperature prevails as is ordinarily found in the tropics, its distribution may well be restricted to regions considerably warmer than central Maryland.

LITERATURE CITED

ARK, P. A., and MIDDLETON, J. T. *Pythium black rot of* Cattleya. Phytopathology **39:** 1060–1064. 1949.

BARY, A. DE. *Untersuchungen über die Peronosporeen und Saprolegnieen und die Grundlagen eines natürlichen Systems der Pilze.* In Bary, A. de, and M. Woronin, Beiträge zur Morphologie und Physiologie der Pilze IV: 1–145, pl. 1–6. 1881a.

———. *Zur Kenntniss der Peronosporeen.* Bot. Zeit. **39:** 521–530, 537–544, 553–563, 569–578, 585–595, 601–609, 617–625. 1881b.

BUISMAN, C. J. *Root rots caused by phycomycetes.* Meded. Phytopath. Lab. "Willie Commelin Scholten" Baarn **11:** 1–51. 1927.

BUTLER, E. J. *An account of the genus* Pythium *and some Chytridiaceae.* India Dept. Agr. Mem. Bot. Ser. **1** (5): 1–161, pl. 1–10. 1907.

———. Pythium *de Baryanum Hesse.* India Dept. Agr. Mem. Bot. Ser. **5** (5): 562–567, pl. 5. 1913.

DRECHSLER, C. *Sources of difficulty in recognizing, identifying, and describing species of phycomycetes.* Proc. Int. Bot. Congr. **2:** 176–181. 1935.

———. *Several species of* Pythium *causing blossom-end rot of watermelons.* Phytopathology **29:** 391–422. 1939.

———. *Three species of* Pythium *associated with root rots.* Phytopathology **30:** 189–213. 1940.

———. *Production of zoospores from germinating oospores of* Pythium ultimum *and* Pythium debaryanum. Bull. Torrey Bot. Club **79:** 431–450. 1952.

HESSE, R. Pythium de Baryanum *ein endophytischer Schmarotzer in den Geweben der Kimlinge der Leindotter, der Rüben, des Spergels und einiger anderer landwirthschaftlichen Kulturpflanzen.* 76 pp., 2 pl. Halle, 1874.

JOCHEMS, S. C. J. *Parasitaire stengelverbranding bij Deli-Tabak.* Meded. Deli. Proefstat. Medan, Sumatra, ser. 2, no. **49:** 1–35, fig. 1–4. 1927.

MATTHEWS, VELMA D. *Studies on the genus* Pythium. 136 pp., 29 pl. Chapel Hill, N. C., 1931.

MEURS, A. *Wortelrot, veroorzaakt door schimmels uit de geslachten* Pythium *Pringsheim en* Aphanomyces *de Bary.* 94 pp. Baarn, 1928.

———. *Parasitic stemburn of Deli tobacco.* Phytopath. Zeitschr. **7:** 169–185. 1934.

MIDDLETON, J. T. *The taxonomy, host range and geographic distribution of the genus* Pythium. Mem. Torrey Bot. Club **20** (1): 1–171. 1943.

SADEBECK, R. *Untersuchungen über* Pythium Equiseti. Beitr. Biol. Pflanzen **1** (3): 117–139, pl. 3, 4. 1875.

SAWADA, K. *Descriptive catalogue of the Formosan fungi, Part III.* Dept. Agr. Gov. Res. Inst. Formosa, Japan, Rept. 27. 1927.

TROW, A. H. *Observations on the biology and cytology of* Pythium ultimum *n. sp.* Ann. Bot. **15:** 269–312, pl. 15, 16. 1901.

VAN LUIJK, A. Pythium de Baryanum *Hesse em. de Bary.* Meded. Phytopath. Lab. "Willie Commelin Scholten" Baarn **13:** 23–28. 1934.

ENTOMOLOGY.—*New species of Olethreutidae from Illinois* (*Lepidoptera*). J. F. GATES CLARKE, U. S. Bureau of Entomology and Plant Quarantine.

This paper is devoted to the description of species of olethreutid moths collected by Murray O. Glenn, of Henry, Ill. Only six species are treated here, although many more, chiefly represented by uniques, are in hand. Mr. Glenn deserves great credit for contributing so much to our knowledge of host associations and of the Microlepidoptera of the region. The photographs of the moths' wings were taken by Robert Bonde, U. S. Department of Agriculture. The drawings are by the author. Types of all the species are deposited in the U. S. National Museum, and paratypes are deposited in the National Museum and in Mr. Glenn's collection.

Eucosma uta, n. sp.

Figs. 1, 1a, 1b

Alar expanse, 20–22 mm.

Labial palpus with second segment very light buff, sprinkled with a few grayish scales; third segment very short, dark gray, buff-tipped. Head ochraceous-buff, face buff. Antenna ochraceous-buff with fuscous spot above on some segments; scape fuscous above. Thorax and forewing light buff; thorax strongly overlaid with fuscous and ochraceous-buff almost to the complete suppression of the ground color; apex of tegula light buff; basal two-fifths of forewing fuscous, except costal third, with considerable olivaceous scaling on basal angle; from slightly before middle of costa an outwardly slanting fuscous fascia extending to and broadening at tornus is preceded and followed by olivaceous; entire costa strigulated with short alternating pale buff and fuscous dashes, the former with a faint metallic luster; costal fold of male extending slightly beyond basal third; in terminal third, and in the dark fascia, several narrow metallic streaks; ocelloid patch obsolete, mainly indicated by two, short, metallic bars and a pair of faintly indicated longitudinal, black lines; cilia olivaceous strongly irrorate with blackish-fuscous basally. Hind wing fuscous; cilia buff with a grayish subbasal line, except in area of basal angle where they are almost wholly grayish. Legs buff overlaid and banded with fuscous. Abdomen buff below, fuscous above.

Male genitalia.—Harpe as figured. Uncus prominent, broad, rounded apically. Socii moderately long, fleshy, pendant.

Female genitalia.—Ovipositor with an anterior, ventral, prominent, evaginated opening. Remainder of genitalia as figured.

Type.—U.S.N.M. no. 61481.

Type locality.—Putnam County, Ill. (July 10, 1939).

Food plant.—Unknown.

Remarks.—Described from the type male and two female paratypes all from the same locality. The females are dated "13. viii. 45" and "5. viii. 47."

The nearest relative of *uta* appears to be *E. atomosana* (Walsingham), from which it differs by the presence of the dark basal patch and the absence of the white costal area and the semimetallic spotting of the forewing. In genitalia *uta* differs from *atomosana* by the evenly rounded uncus, more slender socii, and broader neck of harpe. No females of *atomosana* are available for a comparison of the genitalia.

Epiblema naoma, n. sp.

Figs. 2, 2a, 2b

Alar expanse, 14–18 mm.

Labial palpus with second segment buff, outwardly marked with grayish fuscous; third segment fuscous, buff-tipped. Antenna grayish fuscous with paler, narrow annulations. Head with admixture of buff and fuscous, varying greatly in different specimens, some with the lighter color absent. Thorax marked with three pairs of alternating dark and light transverse bands; in some specimens the dark bands are blackish fuscous and the light bands vary from buff to pale vinaceous. Forewing blackish fuscous; outer margin of basal patch outwardly oblique from costa to middle of wing then straight to dorsum; basal patch followed by a pale transverse shade from dorsum to costa, broader on dorsum; this pale shade varies from buff to pale vinaceous, being more pronounced in the males, and is followed by an outwardly oblique, narrow bar of the ground color; this in turn is followed by a pale terminal portion of the wing; slightly before apex a transverse dash of the ground color, frequently interrupted by pale scaling, extends to vein 5; costa marked for its entire length with alternating light and dark spots; costal fold of male extending to middle of costa; terminal half of wing marked with dull leaden-metallic scales; cilia dull leaden-metallic preceded by a fine, dark subbasal line. Hind wing pale to dark fuscous with base, in males, almost white; cilia light fuscous with darker subbasal line. Legs buff to pale vinaceous the ground color mostly obscured by fuscous suffusion and banding. Abdomen consisting of alternating dark and light bands the extent of each varying with the specimen.

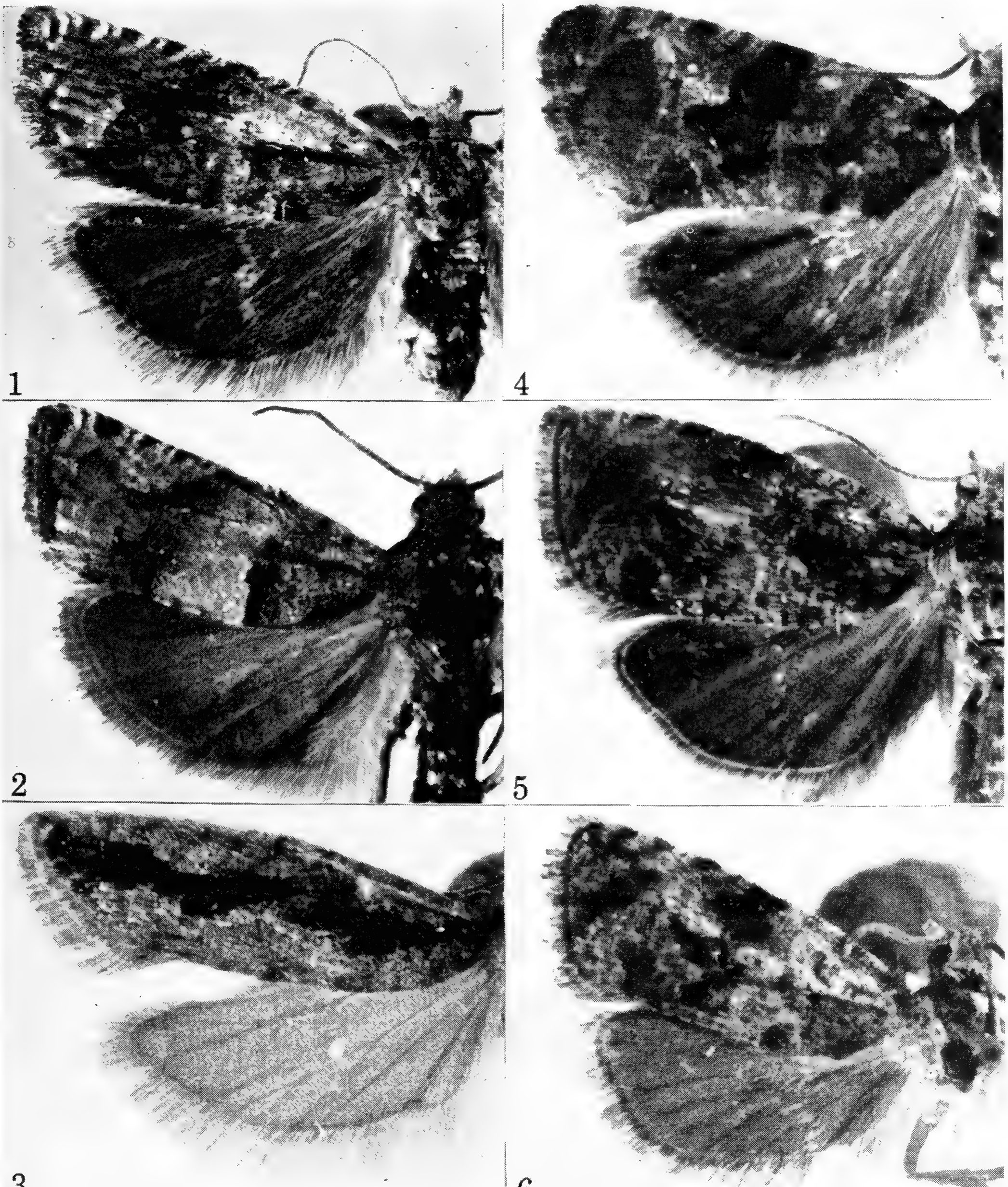
Male genitalia.—Harpe as figured. Uncus bilobed. Clasper strong, sharply pointed.

Female genitalia.—Ovipositor not shown; remainder as figured.

Type.—U.S.N.M. no. 61482.

Type locality.—Putnam County, Ill. (June 25, 1950).

Food plant.—*Ratibida pinnata* (Vent.) Barnhart (roots).



FIGS. 1–6.—New Olethreutidae from Illinois: Left wings. (See explanation at end of text.)

Remarks.—Described from the type male and 8 male and 9 female paratypes all from the type locality. Dates of emergence range from April 28 to June 25 (1948–1950).

As indicated in the description, *naoma* is an extremely variable species, difficult to describe. The wings figured represent an average male, but many of these exhibit much more light scaling. In the females the markings are usually more pronounced and clear-cut, and the majority of them appear much darker than the males. In general appearance and genitalia this species is nearest *E. iowana* McDunnough.

T. N. Freeman, of the Canadian National Museum, has kindly compared some of the specimens of *naoma* with McDunnough's type of *iowana* and remarks as follows: *E. iowana* has "apex of uncus truncate; ventral edge of sacculus strongly arcuate; neck of harpe much deeper excavated ventrally so that the ventral part of the cucullus projects well beyond; juxta arcuate dorsally." *E. naoma* has "apex of uncus bilobed; ventral edge of sacculus less strongly arcuate; neck of harpe shallowly excavated; juxta more truncate dorsally." He further states that in *iowana* "outer edge of basal band runs straight to radius then obtusely angled to costa" while in *naoma* "outer edge of the basal band is irregular and bends in the middle of the wing. Maculation is more distinct and the hind wings are whiter at base, otherwise quite similar."

Epinotia atristriga, n. sp.

Figs. 3, 3a, 3b

Alar expanse, 13–19 mm.

Labial palpus sordid whitish suffused with gray exteriorly on second segment; third segment gray. Antenna dark gray with narrow, paler annulations. Head gray, the scales tipped with sordid white. Thorax and forewing ground color gray with scales tipped with sordid white; tegula with black spot at base; forewing with longitudinal, median, irregular black streak for entire length; on each side of the median streak, particularly dorsally, sordid-white scaling; costal fold of male extending to basal two-fifths and containing expansible, whitish hair pencil; outer three-fifths of costa with some obscure dark spots; cilia gray with dark subbasal line. Hind wing pale grayish-fuscous; cilia lighter with dark subbasal line. Legs dark gray with pale annulations. Abdomen dark gray, somewhat lighter ventrally and anal tuft with ocherous tint.

Male genitalia.—Harpe as figured. Uncus long, curved, bifid. Socii long, narrow, dilated distally.

Female genitalia.— Ovipositor not shown, remainder as figured.

Type.—U.S.N.M. no. 61483.

Type locality.—Putnam County, Ill. (March 17, 1945).

Food plant.—Unknown.

Remarks.—Described from the type male and 14 male and 6 female paratypes all from the type locality. Dates range from March 17 to April 12 (1938–1946).

Formerly confused with *E. vertumnana* (Zeller), to which it is closely related, but differing from it by the uninterrupted dark median streak and much less white scaling dorsally on forewing. The chief differences in the male genitalia are the much broader base of sacculus and narrower, longer spine cluster of *vertumnana.*

Polychrosis sambuci, n. sp.

Figs. 4, 4a, 4b

Alar expanse, 10–13 mm.

Labial palpus pinkish buff; second segment with indistinct subterminal fascia and small basal spot fuscous. Antenna fuscous with paler annulations. Head pinkish buff shading to brownish posteriorly and with a fuscous spot on each side. Thorax cinnamon-buff; posterior tuft cinnamon; base of tegula and median transverse fascia fuscous. Forewing with basal two-fifths leaden-metallic the basal patch almost obliterated by this color and only indicated by a fine blackish-fuscous transverse line near base and another, outwardly curved fascia of the same color at one-fourth nearly obscured by cinnamon-buff scales; from slightly before middle of costa to middle of dorsum an outwardly curved, irregular, blackish-fuscous fascia with a prominent tooth extending well toward termen; dorsal half of this fascia largely overlaid with cinnamon-buff; on tornus a blackish-fuscous spot, overlaid with cinnamon-buff, and bordered by an inverted V-shaped leaden-metallic mark; between this and a smaller, similarly colored apical spot, a large blotch, also similarly colored, covers most of the subterminal area; on apical half of costa several alternating dark and light dashes; cilia mostly leaden-metallic with some cinnamon buff in tornal area. Hind wing fuscous; cilia grayish with dark subterminal line. Legs buff to pinkish buff overlaid and banded with blackish fuscous. Abdomen fuscous above, buff beneath.

Male genitalia.—Harpe as figured. Uncus broad, rounded. Socii small pads with long, coarse setae. Aedeagus slender, with curved distal end and single lateral tooth.

Female genitalia.—Ovipositor not shown; remainder as figured.

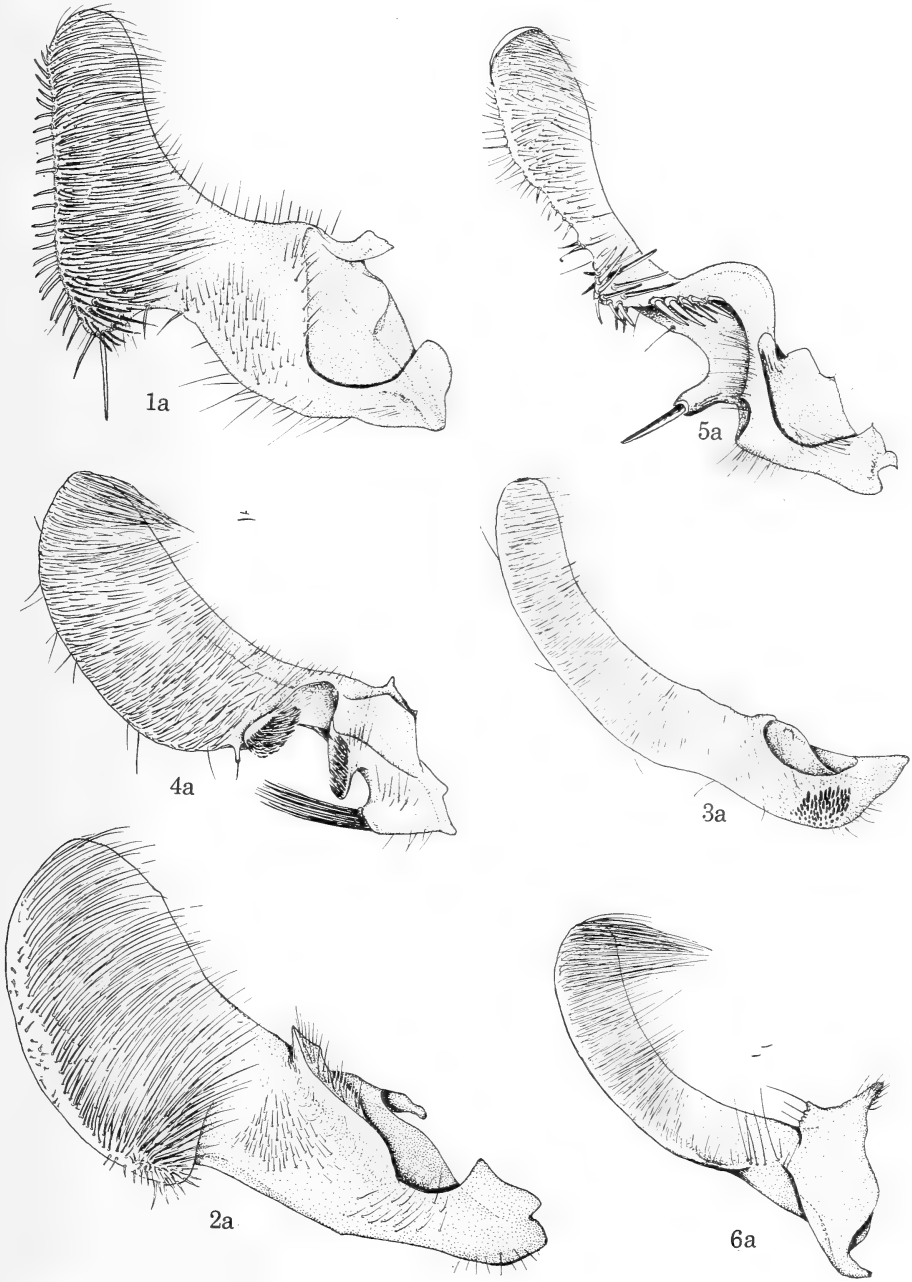
Type.—U.S.N.M. no. 61486.

Type locality.—Putnam County, Ill. (July 3, 1943).

Food plant.—*Sambucus canadensis* L.

Remarks.—Described from the type male and 5 male and 8 female paratypes all from the type locality. The dates range from May 20 to September 4 (1939–1949).

This species is difficult to distinguish from *P. monotropana* Heinrich on color and markings except that in *monotropana* the dark markings are clearer and the leaden scaling is smoother.



FIGS. 1a–6a.—New Olethreutidae from Illinois: Left harpes. (See explanation at end of text.)

The genitalia immediately distinguish the two. The aedeagus of *monotropana* is smooth, that of *sambuci* is armed with a single tooth. The fluted genital plate of *sambuci* immediately separates it from *monotropana*.

Exartema comandranum, n. sp.

Figs. 5, 5a, 5b

Alar expanse, 15–18 mm.

Labial palpus pale buff; second segment with small fuscous spot exteriorly at base and with smoky suffusion exteriorly at apex; third segment almost wholly overlaid with fuscous. Antenna blackish fuscous overlaid with olivaceous almost entire length above. Head fuscous with some tawny scaling in front. Thorax and basal three-fifths of forewing olivaceous, the latter with some admixture of buff; tegula with suffused fuscous spot at base; posterior tuft of thorax dark vinaceous-tawny; basal patch almost obscured by the olivaceous scaling and reduced to an oblique mark from basal angle to slightly before middle of cell; outer two-fifths of forewing dark vinaceous-tawny crossed by several irregular leaden-metallic lines; from middle of costa a short, wedge-shaped, outwardly oblique, blackish-fuscous dash, the dark color almost obscured by vinaceous-tawny scales; on tornus a similarly colored spot; from vein 8, slightly beyond end of cell, to termen at vein 5, an oblique bar of the same color; entire costa marked with short, alternating dark and light strigulae; cilia leaden-metallic mixed with dark vinaceous tawny and fuscous and preceded by a fine blackish-fuscous and tawny line. Hind wing light mummy brown; cilia fuscous mixed with buff with a dark subbasal line. Legs buff overlaid and banded with fuscous. Abdomen fuscous this color nearly obscured by buff beneath.

Male genitalia.—Harpe as figured. Uncus broad basally, tapering to a slender point. Socii small oval pads.

Female genitalia.—Ovipositor not shown; remainder as figured.

Type.—U.S.N.M. no. 61484.

Type locality.—Putnam County, Ill. (June 11, 1942).

Food plant.—*Comandra umbellata* (L.) Nutt.

Remarks.—Described from the type male and 12 male and 4 female paratypes all from the type locality. Dates of both reared and field collected specimens range from May 27 to July 31 (1941–1943).

In appearance *comandranum* reminds one of *merrickanum* Kearfott but lacks the conspicuous subterminal spot and long, pale, oblique line of that species. The genitalia, however, indicate a closer affinity with *E. foedanum* (Clemens) from which it differs by the shorter digitus and longer, stouter spine of Spc^2, and the presence of a small but well-defined signum.

Endothenia microptera, n. sp.

Figs. 6, 6a, 6b

Alar expanse, 10–12 mm.

Labial palpus buff with some fuscous shading exteriorly on second segment; third segment almost wholly fuscous. Antenna fuscous; scape paler. Head grayish with some light brown mixed on vertex. Thorax and ground color of forewing grayish fuscous with darker and ligher markings, the whole appearing mottled; thorax and tegula with narrow, transverse, buff bands; posterior tuft of thorax fuscous; basal patch, an irregular, median, transverse fascia and a slightly curved, transverse bar from vein 8, near end of cell, to vein 5 before termen, fuscous; dark markings separated by leaden-metallic fasciae and spots; on dorsum, about middle of wing, a leaden-metallic spot preceded and followed by a slender buff line; costa with three pairs of short buff strigulae before the dark transverse fascia and three pairs of similar strigulae beyond; cilia leaden-metallic preceded by a narrow fuscous subbasal line. Hind wing fuscous; cilia grayish with dark subbasal line. Legs buff, overlaid and banded with fuscous. Abdomen fuscous above, buff beneath.

Male genitalia.—Harpe as figured. Uncus very broad, tuberculate. Cornutus one, small, with large bulbous base.

Female genitalia.—Ovipositor not figured; remainder as shown.

Type.—U.S.N.M. no. 61485.

Type locality.—Putnam County, Ill. (August 14, 1949).

Food plant.—Unknown.

Remarks.—Described from the type male and 3 male and 4 female paratypes all from the same locality. Dates range from June 12 to September 2 (1946–1949).

In size *microptera* approaches *E. conditana* (Walsingham), to which it is most nearly related. The markings of *microptera* are more pronounced than those of *conditana*, and the former has six pairs of fine, well-defined, buff strigulae on costa of forewing not found in *conditana*. The uncus of *microptera* is about twice as broad as that of *conditana*, the aedeagus is broader and shorter, and the cornutus is less than half the size.

EXPLANATION OF FIGURES

FIGS. 1–1b.—*Eucosma uta*, n. sp.: 1, Left wings; 1a, left harpe; 1b, ventral view of female genitalia with ovipositor removed.

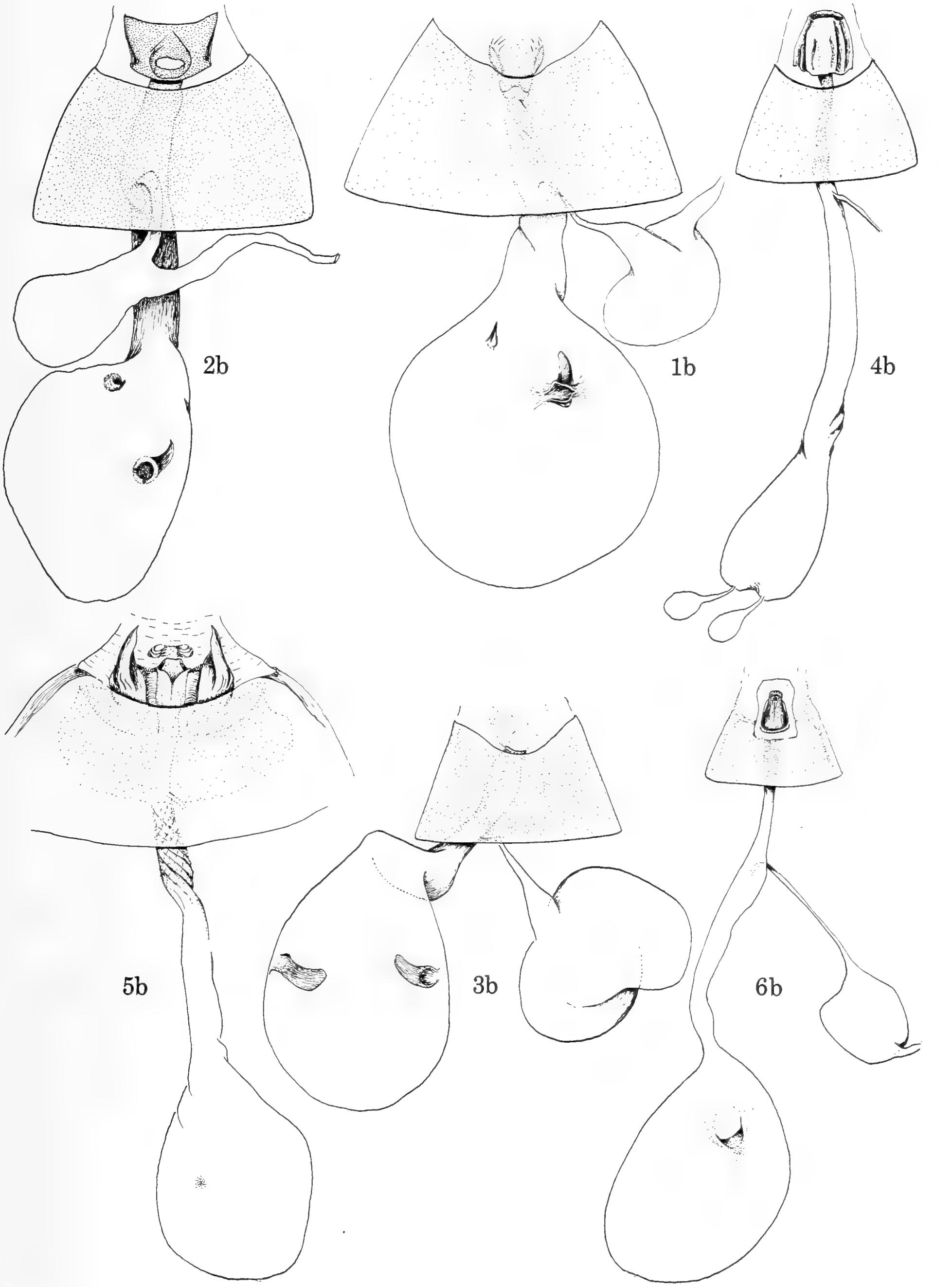
FIGS. 2–2b.—*Epiblema naoma*, n. sp.: 2, Left wings; 2a, left harpe; 2b, ventral view of female genitalia with ovipositor removed.

FIGS. 3–3b.—*Epinotia atristriga*, n. sp.: 3, Left wings; 3a, left harpe; 3b, ventral view of female genitalia with ovipositor removed.

FIGS. 4–4b.—*Polychrosis sambuci*, n. sp.: 4, Left wings; 4a, left harpe; 4b, ventral view of female genitalia with ovipositor removed.

FIGS. 5–5b.—*Exartema comandranum*, n. sp.: 5, Left wings; 5a, left harpe; 5b, ventral view of female genitalia with ovipositor removed.

FIGS. 6–6b.—*Endothenia microptera*, n. sp.: 6, Left wings; 6a, left harpe; 6b, ventral view of female genitalia with ovipositor removed.



FIGS. 1b–6b.—New Olethreutidae from Illinois: Female genitalia. (See explanation at end of text.)

ENTOMOLOGY.—*Eight new Neotropical chrysomelid beetles (Coleoptera).* DORIS H. BLAKE, Arlington, Va.

This paper is composed of the descriptions of eight new Neotropical chrysomelids, two from the West Indies, one from Peru, one from Mexico, and four from Costa Rica.

Phaedon barberi, n. sp.

Fig. 8

Between 6.5 and 7.5 mm in length, shortly and broadly ovate, moderately convex, shining, very finely punctate, pale reddish brown with black antennae, scutellum, and undersurface, except prosternum, and legs.

Head broad and flat across vertex, surface polished and finely punctate, a faint median line connecting with a V line running down on either side to the antennal sockets, lower front short, finely punctate, tip of jaws dark. Antennae short, dark, the five basal joints narrow, remaining distal joints much thickened and compressed. Prothorax more than twice as wide as long, with the sides curving forward so as to conceal the eyes from the sides partially, a rather coarse punctation along the lateral margins to basal margin and on anterior margin behind the eyes, more finely punctate on disc. Scutellum dark. Elytra broad, convex, a distinct humeral callosity, surface shining, distinctly but not coarsely punctate, the punctures not striate but with a tendency toward striation. Body beneath and legs shining, often with a bluish or metallic luster, prosternum pale except in the middle about coxae. First abdominal segment not a great deal longer than second. Hind tibiae a little curved. Claws simple. Length 6.5–7.5 mm; width 4.6–5.5 mm.

Type male and 9 paratypes, U.S.N.M. type no. 61616, collected by R. G. Oakley at Yauco, Puerto Rico, February 9 and March 28, 1933. In the Museum of Comparative Zoology, Cambridge, Mass., 5 paratypes from Yauco, Puerto Rico, collected by R. G. Oakley in April 1934, and 12 from Lares, Puerto Rico, collected by Oakley in April 1934.

Remarks.—This, the second species of *Phaedon* to be described from the West Indies, is not entirely typical, not having striate-punctate elytra. *Leucocera ferruginea* Chevrolat from Haiti is similar in its ferrugineous coloration but has the pale yellow antennae typical of the genus as well as pale legs and undersurface, and is definitely striate-punctate. This is a species that had been set aside for future description by H. S. Barber.

Diabrotica neoallardi, n. sp.

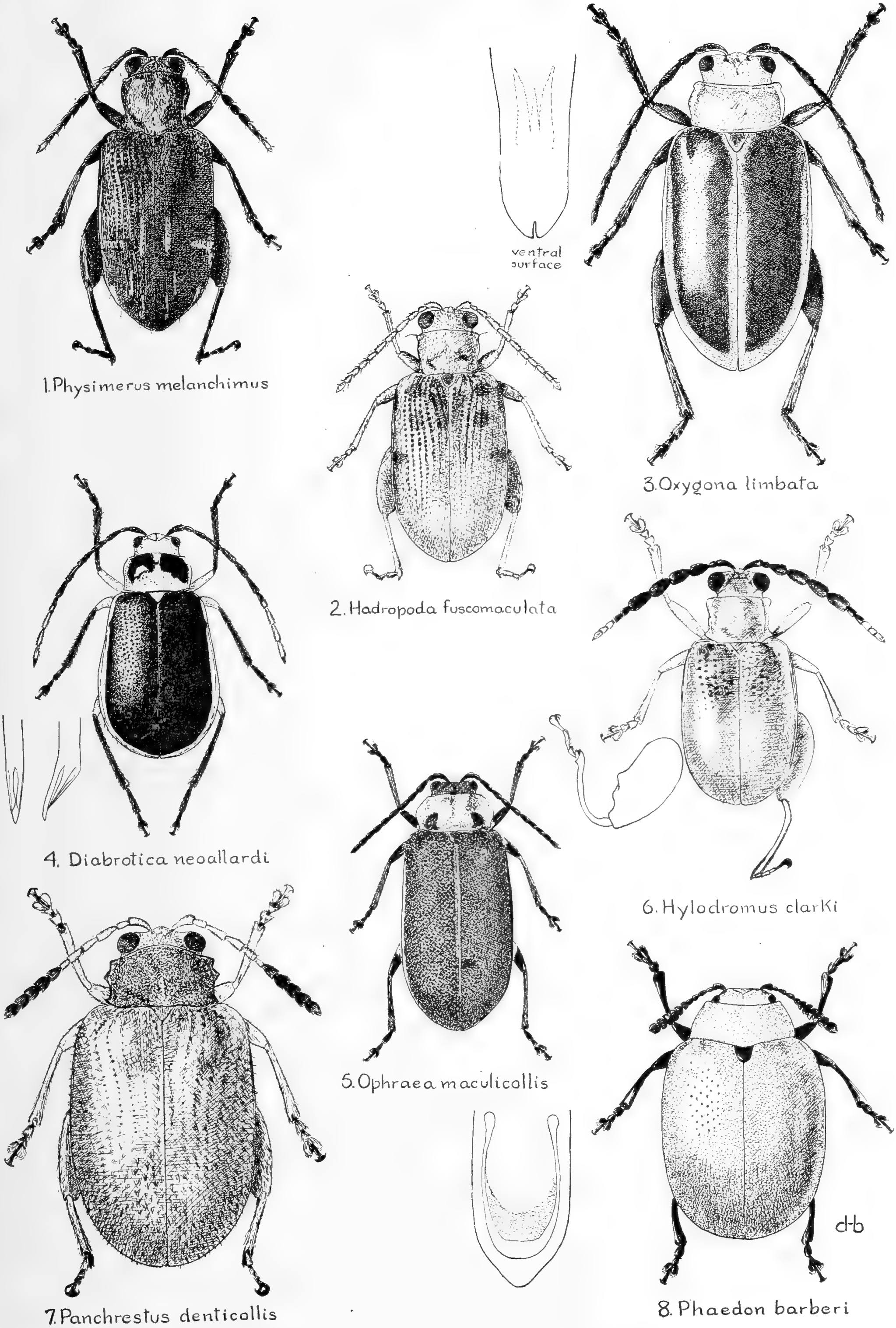
Fig. 4

About 6.5 mm in length, elongate oval, moderately shiny although alutaceous, the prothorax finely and the elytra coarsely punctate, the head, undersurface, femora, borders of the prothorax and elytra, and scutellum pale yellow, two piceous spots on the prothorax nearly covering the anterior half, the elytra, except the margin, deep blue, tibiae and tarsi and antennae except the apical joints dark.

Head pale, orange-yellow on top and yellow on the lower front, smooth, faintly shining, alutaceous, frontal tubercles clearly marked with a median depression above them. Antennae extending below the middle of the elytra, very slender and hairy, third joint a little shorter than fourth, remainder subequal, dark, the three distal joints mostly pale. Prothorax a little less than twice as broad as long with curved sides and a somewhat curved transverse depression below the middle, finely alutaceous and distinctly punctate, pale yellow with two broad piceous areas covering most of the anterior half of the prothorax except the margin and curving down towards the basal angles. Scutellum pale. Elytra wider toward apex, with a wide explanate margin that is pale, dark blue over disc, densely and coarsely punctate and alutaceous, slightly pubescent at the apex and about the apical margin. Epipleura pale. Body beneath entirely pale yellow, femora pale, tibiae and tarsi piceous and very hairy. Length 6.7 mm; width 3.4 mm.

Type male, U.S.N.M. type no. 61617, collected by H. A. Allard at Tinga María, Peru, winter of 1949–50.

Remarks.—Except for the unusual dark markings on the prothorax, this species resembles a number of species of *Diabrotica* with dark elytra having a pale margin, but I have hunted vainly through the types of *Diabrotica* in the British Museum for one like it. *D. albidocincta* Baly from Brazil has a dark head and thorax with a pale margin, and the elytra are black. *D. limbatipennis* Baly is smaller and similar in coloring except for the prothorax. *D. cinctipennis* Baly also from Peru has deep blue or green elytra, and



1. Physimerus melanchimus

2. Hadropoda fuscomaculata

3. Oxygona limbata

4. Diabrotica neoallardi

5. Ophraea maculicollis

6. Hylodromus clarki

7. Panchrestus denticollis

8. Phaedon barberi

FIGS. 1–8.—New Neotropical Chrysomelidae.

the prothorax has a dark vitta on each side. There is also a dark spot on the head. *D. digna* Gahan from Brazil is very shiny and without dark thoracic markings. *D. flavocincta* Baly from Colombia has a black head and the elytra are parallel-sided with impunctate surface. *D. flavomarginata* Baly from Colombia has minutely punctate elytra. *D. staudingeri* Baly from Colombia, a larger species, has the lateral margin of the prothorax alone pale and is coarsely punctate.

This species is dedicated to H. A. Allard who has collected a great many botanical and zoological specimens not only in Peru but elsewhere. There is already a *D. allardi* Jacoby from Mexico, named for another Allard.

Ophraea maculicollis, n. sp.

Fig. 5

About 4.5 mm in length, oblong oval, feebly shining under the short, pale, appressed pubescence, densely and coarsely punctate, black with the lower front of head, prothorax and basal part of femora pale, the prothorax with a black longitudinal spot on each side extending from the middle to the base.

Head coarsely punctate, a median groove down occiput, space between antennal sockets feebly carinate, tubercles poorly marked, lower front from antennal sockets to labrum pale and likewise punctate, mouthparts and rest of head dark, with fine pale pubescence not concealing punctation. Antennae entirely dark, third joint longer than succeeding joints which are subequal. Prothorax just about twice as wide as long, sides rounded, almost angulate, depressed deeply on each side and in the middle near the anterior margin; densely and coarsely punctate, pale yellow with a spot on each side from the middle to the base. Elytra elongate, parallel-sided, with sutural edges a little raised, coarsely and contiguously punctate, with each puncture having a flat reflecting bottom, so that the whole sparkles somewhat; a fine appressed pale pubescence, not concealing surface. Epipleura wide, coarsely punctate and pubescent and extending nearly to the apex. Body beneath shiny, black, except the prosternum and basal half of femora, claws toothed. Length 4.5-4.6 mm; width 2 mm.

Type, U.S.N.M. type no. 61618, taken at San Francisco, Calif., March 20, 1939, on orchids from Mexico. A second specimen, also on orchids from Mexico was taken at Laredo, Tex., January 29, 1945.

Remarks.—None of the eight species described by Jacoby from Mexico and Central America, which constitute all the species previously known in the genus, has markings such as occur on the thorax of this species, although one, *O. opaca*, has a broad median black stripe, and *O. subcostata* has a broad central black band.

Oxygona limbata, n. sp.

Fig. 3

Between 8 and 9 mm in length, oblong oval, shining yellowish brown, the antennae, tip of jaws, legs, breast and abdomen, and the elytra except for suture and lateral margins deep reddish brown, almost piceous.

Head rounded and polished over occiput with a median groove down the front to the tubercles, the tubercles rounded and swollen, the interantennal area below them rather depressed without much trace of a carina, jaws large and dark. Antennae long, slender and dark, third joint shorter than fourth, joints 4 to 7 subequal, distal joints a little shorter. Prothorax more than twice as broad as long with curved sides and prominent toothing at anterior and basal angles, surface faintly alutaceous and very finely punctate with a row of coarser punctures along lateral margin, pale yellowish brown with faintly deeper brown traces of a transverse fascia. Scutellum reddish brown. Elytra broader than prothorax, shining, finely punctate, deep reddish brown, with the suture and lateral edges pale yellowish brown; epipleura pale. Body beneath shining, the breast, abdomen and legs deep reddish brown verging on piceous. Length 8-9 mm; width 2-4.5 mm.

Type male and 2 paratypes female, U.S.N.M. type no. 61619, collected on *Solanum torvum*, Guadalupe, Costa Rica, May 25, 1936, by E. Marin.

Remarks.—This is the third species of the genus to be described from the North American Continent. The dark color pattern of the elytra differs from the pale-yellow-colored *O. acutangula* Chevrolat, and *O. bifasciata* Jacoby, the second one from the North American Continent, is banded. *O. adumbrata* Clark, from the Amazon River, has the elytra clouded with dark ferrugineous except at the margin, but the femora in this species are pale.

Panchrestus denticollis, n. sp.

Fig. 7

About 6.5 mm in length, broadly oblong oval, faintly shining reddish brown under a yellowish brown pubescence, the head and prothorax coarsely and densely punctate, the elytra less coarsely and striately punctate, the antennae pale with joints 7 to 11 much thickened and dark; prothorax with three sharp lateral teeth on each side, hind tibiae appearing double spurred at apex.

Head with interocular space a little more than half width of head, coarsely and densely punctate over occiput and with short yellow-brown pubescence, frontal tubercles prominent with a deep groove between, space between antennal sockets wide and a little produced, this carina very short, a triangular depression below over labrum, the lower front unusually short, labrum large. Antennae not very long, basal joints pale, first and third longest, sixth joint shorter and thinner than fourth or fifth, about the length of second joint, joints 7 to 11 dark, very hairy, and fully twice as wide as basal joints. Prothorax short compared with the elytra, not twice as wide as long, moderately convex with an oblique depression below the middle on each side, the sides 3-toothed, the sharp apical angle forming one tooth, the second below this before the middle, and the third not so sharp at the basal angle; the surface of the disc contiguously and coarsely punctate and with short erectish yellow brown pubescence, much rubbed in this specimen. Scutellum densely pubescent. Elytra much wider than prothorax, moderately convex and shining beneath the yellowish-brown suberect pubescence, the pubescence in this specimen probably rubbed from the central portion but on the sides and the apex the hairs tending to mat together at the tips forming little cone-shaped tufts. Striate punctures not coarse but darker in coloring and toward the apex becoming somewhat indistinct. Epipleura broad and extending nearly to the apex. Body beneath and legs shining reddish brown, the posterior femora much thickened and with considerable yellowish-brown pubescence, posterior tibiae short and straight, ending in a sharp spur with another inserted before the end, the posterior first two tarsal joints thinner and shorter than the corresponding ones in the anterior legs. Anterior tarsal claws appendiculate, with the basal tooth sharp. Length 6.5 mm; width 3.3 mm.

Type, U.S.N.M. type no. 61620, collected on the western slope of the Irazu Volcano, Costa Rica, 1,500 to 2,000 meters, by T. Assmann, on April 30, 1926, from the Nevermann collection.

Remarks.—The Rev. Hamlet Clark's Catalogue of Halticidae, part 1, has been criticized by both Jacoby and Weise because of the numerous genera that he has made. Anyone who has examined the Neotropical Oediopodes is struck by their great diversity of form and the difficulty of cataloguing them under a few genera. Bowditch[1] wrote of attempting "to squeeze" a number of species that he was describing into Clark's genera, but apparently with no great faith that they belonged in those genera, rather than describe any new genera. So I am placing this very distinct species under Clark's *Panchrestus*, chiefly because Clark in describing *P. pulcher* from the Amazon wrote of that species as having a toothed prothorax and with the antennal joints much thickened and darker toward the end. This toothing of the prothorax is unusual, and I know of no other species with it in this group.

Hadropoda fuscomaculata, n. sp.

Fig. 2

About 4.5 mm in length, oblong oval, faintly shining, pale yellow brown with pale yellowish pubescence, the elytra with a reddish brown area from the humerus across to the suture and down, a reddish-brown spot below in the middle and one near the margin halfway down the elytra.

Head entirely pale, the interocular space about half the width of the head, occiput coarsely and densely punctate with a thin median ridge and on either side a ridge from near the eye to the tubercles, tubercles well defined, a narrow carina between antennal sockets running down the lower front, lower front long. Antennae pale brown, not extending much below the humeri, fourth joint longer than third and subequal to fifth and sixth, remainder shorter. Prothorax a little wider than long with nearly straight sides slightly constricted near the base, a seta-bearing nodule at each corner, disc uneven, the anterior middle being convex and below on either side with a hollowed out depression, surface densely and moderately coarsely punctate and with short fine pubescence. Scutellum reddish brown. Elytra much wider than prothorax, rather flat and without callosities or depressions, with moderately coarse striate punctures, faintly shining under the short pubescence, pale yellow-brown with reddish-brown spots, a brownish area from the

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[1] Bowditch, Trans. Amer. Ent. Soc. **41**: 498. 1915.

humerus to suture and down, another spot slightly below in the middle and another on the side at the middle of the elytra; epipleura pale and wide and extending nearly to the apex. Body beneath pale, shining, lightly pubescent, the hind femora with more pubescence and greatly thickened, hind claw inflated. Length 4.6 mm; width 2.2 mm.

Type, female, U.S.N.M. type no. 61621, taken at Miami, Fla., from a plane from Natal, Brazil, via Puerto Rico, January 15, 1943.

Remarks.—Although there is no definite locality for this beetle, the fact that it came from a plane that flew from Natal, Brazil, to Florida by way of Puerto Rico makes it pretty certain that the beetle came aboard in the neighborhood of the West Indies, and quite probably Puerto Rico, as it is a typical *Hadropoda*, a group of beetles that so far has been found only in the West Indies. It differs from any of those previously described in its elytral markings. *H. calva* Blake, from the Dominican Republic, is a little smaller beetle with somewhat similar spotting but has longer antennae.

Hylodromus clarki, n. sp.

Fig. 6

About 4 mm in length, elongate oblong oval, very shiny, deep reddish brown with pale yellow anterior legs, hind femora reddish brown, paler at apex and on underside, antennae with the first eight joints deep brown, rest paler, joints 3 to 6 much enlarged; elytra finely striate punctate with coarser punctures in the depression below the basal callosity, hind femora with a prominent nodule in middle of lower surface and a tooth below that.

Head with large protuberant eyes, the interocular space about half width of head, occiput shining reddish brown, a single puncture in middle and a fovea on either side, frontal tubercles swollen, a deep groove above and between them; antennal sockets very close and the space between them slightly carinate, this swelling very short and not extending down the lower front, the lower front short, labrum wide. Antennae more than half the length of the beetle, joints 3 to 6 enlarged to twice the width of the first two and longer than the basal joint, joints 7 to 11 abruptly narrowed and short, joints 1 to 8 dark brown, 9 and 10 pale, 11 light brown. Prothorax scarcely a third wider than long with large basal and apical toothing and concave sides narrowly margined, disc a little depressed in basal part, shining deep reddish brown, finely punctate. Scutellum a little deeper brown than the reddish-brown elytra, elytra with prominent humeri and deep intrahumeral depression, also a broad and deep depression below the basal callosity, finely and striately punctate except in the depression, toward the apex and on sides the punctures becoming faint and disappearing. Epipleura broad and extending nearly to apex. Body beneath shining reddish brown, the anterior pairs of legs and underside and apex of hind femora pale yellow, hind femora with a prominent nodule at the middle on lower side and below this a tooth, hind femora slender, bowed and long, nearly glabrous, at the tip ending acutely and with a spur, thus making it appear two spurred, claw joint inflated. Length 4.3 mm; width 2 mm.

Type male, U.S.N.M. type no. 61622, collected at Hamburgfarm, Reventazon, Ibene Limón, Costa Rica, on March 28, 1930, by F. Nevermann.

Remarks.—I have not examined Clark's species *H. dilaticornis* from the Amazon River, on which the genus *Hylodromus* is based, but have seen a cotype of *H. basalis* Jacoby from Panama. Possibly neither Jacoby's species nor mine belongs in Clark's genus, in which the third to sixth antennal joints are dilated and flattened and in which the body is pubescent. In the first two species the antennal joints are dilated but not flattened, and the beetles are shining and nearly glabrous except for a few scattered hairs near the apex and along the apical margin and, as Jacoby himself stated, resemble a great deal *Homammatus nitidus* Clark except for the antennal dilation and the peculiar curvature of the hind tibiae which is present in all three species. Whether Jacoby's and my species are congeneric with Clark's or not, I do not see any reason why Weise[2] should synonymize *Hylodromus* with *Euphenges*, and I hereby reestablish Clark's genus *Hylodromus* and dedicate this species to him. *H. basalis* Jacoby closely resembles *H. clarki* but differs somewhat in coloring, having a darker head and prothorax. There is some difference in the color of the antennal joints, also; in *H. clarki* the first eight instead of seven joints are dark. *H. basalis* also has a wider and deeper intrahumeral sulcus and stouter, more pubescent hind tibiae.

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[2] Weise, Ark. för Zool. **14:** 153. 1921.

Physimerus melanchimus; n. sp.

Fig. 1

About 5 mm in length, oblong oval, shining black beneath the fine appressed pubsecence, prothorax narrow, constricted before the base, with a median callosity anteriorly, elytra with a basal callosity on each side of the scutellum, coarsely and striately punctate, the pubescence with paler areas in the form of traces of vittae and an interrupted fascia in the apical half.

Head entirely black with large eyes, interocular space scarcely half the width of the head, occiput coarsely punctate and with a fine median ridge and on either side a groove from the eye to the tubercles, tubercles swollen, carina between antennal sockets short and narrowly produced, lower front long with large mouthparts. Antennae with third joint longest, joints 3 to 5 deep brown, joints 6 to 8 black and thicker, joints 9 to 11 brown and thin. Prothorax as long as wide with a tiny seta bearing nodule at each corner, constricted before the base, a callosity in middle anteriorly and a depression on each side below this near base, surface entirely dark, covered with fine appressed pubescence. Scutellum dark and pubescent. Elytra considerably wider than prothorax, entirely dark except for the pale pubescence in the pattern of interrupted vittae and an interrupted fascia below the middle in apical half, shining beneath the pubescence, rather coarsely striate punctate, the interstices raised in slight costae, a callosity on each side of the scutellum with a depression below it; epipleura black and shiny and wide to the apical curve. Body beneath shining black, with a light pubescence except on the hind femora that are more pubescent, hind claws inflated. Length 4.4–5 mm; width 2–2.2 mm.

Type male, U.S.N.M. type no. 61623, Las Mercedes, Costa Rica, October 30, 1922, from the Nevermann collection. One other specimen, a female, collected by N. L. H. Krauss at El Valle, Panama, January 1947.

Remarks.—The antennae of this species, in having joints 6–8 thickened, resemble the antennae of *Homammatus nitidus* Clark, an entirely glabrous species that is much more robust.

MAMMALOGY.—*A new hedgehog from Africa.* Henry W. Setzer, U. S. National Museum.

In cooperation with the United States Naval Medical Research Unit No. 3 and the Chicago Natural History Museum, studies have been started on the mammals of the Anglo-Egyptian Sudan and Egypt. As a result of these studies the hedgehog from the Sudan has been found to differ from the kinds known to inhabit adjacent areas. It is with great pleasure that I name this interesting mammal for J. S. Owen, District Commissioner, Torit, Equatoria Province, Anglo-Egyptian Sudan, who did so much to make the field work of the Unit a success. All measurements are in millimeters, and the capitalized color terms are from Ridgway's *Color standards and color nomenclature.*

Erinaceus (Atelerix) pruneri oweni, n. subsp.

Type.—Chicago Natural History Museum, no. 67047, adult female, skin and skull, from Torit, 2,000 feet, Equatoria Province, Anglo-Egyptian Sudan. Obtained April 9, 1950, by Harry Hoogstraal, original no. 5478.

Specimens examined.—Seven, all from Torit.

Distribution.—Known only from the type locality.

Diagnosis.—Spines of upper parts longitudinally striated and marked with the following pattern: Army Brown followed successively by a band of pure white (2 to 4 mm), a band of Army Brown shading into black (5 to 6 mm), a band of grayish white (2 to 4 mm), and a black base (2 to 4 mm); a few spines are entirely white. The ears and the muzzle to immediately behind the eyes Olive Brown; dorsal surfaces of hands and feet Snuff Brown with a generous admixture of white hairs; mystacial vibrissae black; forehead, shoulders, sides of body, upper parts of limbs, and belly with pure white hairs. Palms and soles naked; hind foot four toed. Skull robust; rostrum relatively narrow; width across zygomatic arches relatively small; nasals rather wide and long; lambdoidal crest moderately developed; upper molars relatively massive.

Measurements of type specimen.—Total length 215; length of tail 24; length of hind foot 32;

length of ear 29; condylobasal length of skull 43.9; length of palate 25.2; width of rostrum at level of infraorbital foramen 11.6; length of nasals 13.1; least width behind postorbital processes 11.4; width across zygomatic arches 26.7.

Comparisons.—*Erinaceus pruneri oweni* differs from *Erinaceus pruneri hindei*, as known from Ulukenia Hills and Kapiti Plains, British East Africa, as follows: Dorsal color somewhat darker but hands and feet lighter; rostrum decidedly narrower and longer; width across zygomatic arches less; nasals wider and longer; occipital region more nearly perpendicular; lambdoidal crest, in animals of comparable age, more developed; molars more robust; P^2 decidedly larger; postpalatal bridge less developed.

No specimens of *Erinaceus pruneri atratus* are available, but from the description, *E. p. oweni* is lighter in color and larger in all measurements taken. Also, it is apparent that *Erinaceus pruneri pruneri* is different in that the area immediately below the eye is white whereas in *E. p. oweni* this region is dark.

Remarks.—There is some variation in color of these specimens, but this is probably owing to the manner in which the skins have been prepared. If the spines are laid flat in preparation the general tone, as observed from above, is a smoky color; if the spines are semierect the color is darker. Another contributing factor is the amount of pigment on the tip of the spines. If this is slight the general effect is lighter and conversely if there is a relatively wide band at the tip the color appears darker. The only immature specimen in the series is decidedly darker in color than any of the adults. In all specimens except one, the maxillary bone touches the nasal on each side for at least 1.5 mm.

All the specimens were obtained in savanna type country between January 7 and April 9.

Obituary

Ida Albertina Bengtson.—A pioneer woman of science passed away on September 6, 1952. Born in Harvard, Nebr., on January 17, 1881, of parents who were Swedish immigrants, Ida A. Bengtson received a liberal education which led to an A.B. degree from the University of Nebraska in 1903. In those days few women were interested in the physical and biological sciences, and these subjects were not among Ida Bengtson's interests. She majored in languages and mathematics. She was elected to Phi Beta Kappa.

Shortly after graduation she came to Washington to be a cataloger in the library of the U. S. Geological Survey. She became acquainted with one of the few women who at that time held Federal Civil Service positions in science. She compared her own professional life with that of her friend and decided that for her the life of a scientist would be more interesting than that of a keeper of scientific books and records.

In Ida Bengtson ideas led to action. She resigned from the U. S. Geological Survey in 1911 and entered the University of Chicago to study bacteriology, with chemistry and physiology as minor subjects. She received the M.S. degree in 1913; held a university scholarship for two years; and received the degree of Ph.D. in 1919. After a year as bacteriologist in the Chicago Department of Health, she was appointed in 1916 to be an assistant bacteriologist in the Hygienic Laboratory (now designated the National Institutes of Health) of the United States Public Health Service, with an annual salary of $1,800. She was the first woman of science in U.S.P.H.S. Low as her entrance salary appears when compared with those of the present time, it was very good in those days. Dr. Bengtson told about the astonishment among her professors and fellow graduate students when she, a woman, received so attractive an appointment.

Within the next 20 years, eight or ten more women entered the Hygienic Laboratory as scientists. In obtaining their positions it was well for all of them that the pioneer woman, who by that time was a senior bacteriologist, was filling her position so ably.

In scientific investigation Dr. Bengtson was painstaking and thorough; her conclusions were conservative. In teamwork she was capable and amicable. She was a good teacher, and for a few weeks annually for many years she had opportunity to exercise that talent as one of the instructors of the orientation class of incoming medical officers. Other evidence of her ability as a teacher remains in the competent *dieners* at the National Institutes of Health who were so fortunate as to receive training under her.

Dr. Bengtson was the sole or senior author of many papers, most of which were published in Public Health Reports or in bulletins of the Hygienic Laboratory or National Institute of Health. She published a number of papers on miscellaneous bacteriological subjects, most of them appearing during the early years of her career. She made a prolonged study of three subjects: (1) anaerobes and their toxins; (2) trachoma; (3) rickettsial diseases.

Dr. Bengtson's work on anaerobes and their toxins covered two periods. During the earlier period (1920–1923) *Clostridium botulinum* was of especial interest to her. In the course of these studies she experienced the thrill of discovery when she identified a new variety, "C," of the organism, which she obtained from a culture grown from larvae of the green fly, *Lucilia caesar*. The toxin was responsible for an outbreak of paralytic disease (limberneck) in chickens. During the later period (1934–1939) she carried on basic studies which led to the establishment of the official U. S. and international units for standardizing the antitoxins specific for the four toxins most commonly involved in cases of gas gangrene—those produced by *Clostridium perfringens*, *C. oedematiens*, *C. septicum*, and *C. histolyticum*.

In 1924 Dr. Bengtson went to Rolla, Mo., to study the etiology of trachoma in the U. S. Public Health Service Trachoma Hospital. It was a difficult problem, not yet solved. The seven years spent in Rolla were marked by a slowing in the publication of scientific papers. The experience in Rolla was, however, a good preparation for Dr. Bengtson's later assignment, because among the various organisms which she considered as a possible causal agent of trachoma were the rickettsia.

In 1937, as a member of the "typhus unit," the study of rickettsial diseases became Dr. Bengtson's major assignment. This unit was comprised of a team which studied the rickettsial diseases of Rocky Mountain spotted fever, endemic and epidemic typhus. Later, "Q" fever and Tsutsugamushi disease (scrub typhus) appeared and were included in the studies.

An important problem for the bacteriologist in the study of rickettsial diseases was to find a method of growing the organisms free of tissues in quantities sufficient for making serological diagnostic tests. In 1938 Herald R. Cox of the U.S.P.H.S. Rocky Mountain Laboratory discovered that the yolk sac tissue of the developing chick embryo provided a suitable medium for prolific growth of rickettsiae. Dr. Bengtson was in a position to put this discovery into immediate practical use, and she entered into the most productive period of her career.

She modified the complement fixation test (a serologic test) adapting it for the detection and differentiation of rickettsial infections. It was also of great value in the study of serum from man and from rats (a species which harbors the typhus virus) for the purpose of detecting past infections. Dr. Bengtson's technique is now in wide use.

She had done some of the early work in the tissue culture of typhus rickettsiae which was of great importance in the subsequent development of the vaccine which played such an important part in the protection of our troops against typhus, one of the major wartime diseases. As World War II progressed the demands upon Dr. Bengtson increased, with many questions constantly being raised regarding rickettsial infections in the Armed Forces. Dr. Norman Topping, who was chief of the Rickettsial Unit during World War II praised her in these words: "Dr. Bengtson was an indefatigable worker, a true disciple of the scientific method, and loyal to her country, her institution and her colleagues." She retired in 1946.

Dr. Bengtson was a member of numerous scientific organizations including Society of American Bacteriologists; Society for Experimental Biology and Medicine; American Association for the Advancement of Science (fellow); Washington Academy of Sciences; Sigma Xi. She was president of the Washington Branch of the Society of American Bacteriologists in 1943–44, and Councilor from the Branch to the National S.A.B. during 1945 and 1946. She was awarded the Typhus Medal of the American Typhus Commission in 1947.

During the period of her greatest scientific activity, Dr. Bengtson found diversion on her farm, which with its big house of colonial architecture is beautifully located in the foothills of the Blue Ridge Mountains of Virginia. She was endowed with great endurance, and after a week of heavy duty she could turn with equal facility and skill to the management of her 370 acres. Although she had not had previous experience of living on a farm, she had inherited a love of the land from a long line of Swedish ancestors. During the ten years of her ownership she converted the status of her farm from nonproductive to productive. She was interested in historic homes and made many trips around the country to see them, especially during garden week.

Ida Bengtson was gentle, pleasant, friendly, rather reserved; she had a keen sense of humor which she tried to keep hidden, but a faint twinkle in her eyes usually gave her away. Her death brought sorrow and a feeling of deep loss to her friends.

Alice C. Evans.

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PHYSICS.—*Looking ahead in mechanics.*[1] Walter Ramberg, National Bureau of Standards.

Mechanics is an old science. It derives its name from the Greek word for machine, μηχανή," where the "machine" may be any means for applying forces to a body. Mechanics was *the* science to Kepler when he described the motion of the heavenly bodies. It was *the* science to Newton when he explained these motions by his universal law of gravitation. Mechanics was *the* science to mathematicians and physicists like Euler, Lagrange, Cauchy, Poisson, Green, and Lord Kelvin, who worked out the relations between loads and displacements in elastic bodies (ref. 1, p. 1–31), and the propagation of waves in elastic media, including the elastic "aether" which filled the void between the stars and transmitted the vibrations of light between them according to the physicists of a hundred years ago (ref. 2, p. 89–103).

Mechanics ushered in the industrial revolution with Watt's steam engine, Stephenson's locomotive, and Fulton's steamship. It continued to advance man's productivity and to speed him and his goods ever faster from place to place during the last half of the nineteenth century, but it gradually lost to electricity its hold on the imagination of the young. It could not match the speed and agility of the electron in carrying messages around the globe in one-fifth of a second and in carrying out commands of infinite variety with practically no inertia or delay. The age of the electron started with Morse's telegraph in the 1840's, and it is still with us. Its position as the "prima donna" of the sciences has not been challenged until a few years ago when the nucleus showed its explosive possibilities.

Mechanics is taken for granted today by the public, and it is remembered by its shortcomings rather than by its accomplishments. It is remembered when an airplane crashes because of mechanical failure or when our advance into the "push-button" age is delayed because we do not have the materials which retain their strength and rigidity at the high operating temperatures contemplated for some of the engines and missiles of the future.

These mechanical failures and shortcomings have made us painfully aware of the need for keeping research in mechanics abreast of that in the other branches of the physical sciences. They illustrate once again the interdependence of the physical sciences, the fact that no one branch can advance far without requiring added support from the other branches.

As one who has been interested in research in mechanics for most of his professional life, I propose to review briefly present trends in the mechanics of solid materials and structures and to extrapolate these trends for some years ahead. We all know the dangers of extrapolation, but as human beings we all share a passion for forecasting the future, whether it is about a better world or about the outlook in our profession.

NEW MATERIALS

Let us consider new materials first. Man's state of civilization is often characterized by the materials from which he fashions his tools and armor. We speak of a stone age, a bronze age, an iron age. The iron age extends into the beginning of

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[1] Retiring address as President, Washington Academy of Sciences. Presented before Academy on February 19, 1953.

our century. It has not come to an end, but aluminum alloys have shown that they can provide a lighter structure than steel alloys. Today we have aluminum alloys which are more than four times as strong as structural steel of the same weight. These alloys have acquired a monopoly position in the structures of aircraft and they are invading other fields of engineering formerly reserved for steel. We now have busses, railroad cars, ships, tall buildings, and even bridges constructed of aluminum alloys. The aluminum alloys with their density of 2.7 are being jostled at the lower end of the scale of densities by the magnesium alloys with their density of 1.8. These alloys have already proved their advantages in applications such as airplane passenger seats, the skin of high-speed research airplanes, and liquid fuel tanks, in which adequate flexural rigidity as well as strength at minimum weight is required. We may expect an extension in the use of magnesium alloys as better alloys are developed which will equal the best aluminum alloys in values of strength-weight ratio as well as flexural rigidity-weight ratio.

Densities still lower than 1.8 are possible with structural plastics. There were those who expected that these plastics would revolutionize airplane construction with the coming of the brave new world after the end of World War II. They have been disappointed. Structural applications have been confined to a few types of small aircraft in which most of the wing, fuselage, and tail structure consists of panels molded from reinforced plastic, and to certain special cases such as airplane canopies and radomes in which adequate structural strength had to be combined with other requirements such as transparency to light and to radio waves. However, it must be emphasized that plastics are making a vital and growing contribution to the structural performance of aircraft in a very different manner. Plastics in the form of synthetic adhesives of surprising strength, adhesion, and stability have been developed for the bonding of metals to metals as well as metals to non-metals (*3*). These adhesives have made possible the so-called "sandwich construction" (*4*) in which two thin sheets of high strength metal are bonded to a light weight core to form a stiff plate. This is used as a structural element in the control surfaces in flooring, and in other places on aircraft. Synthetic adhesives of British manufacture have been used extensively in England to replace rivets on aircraft resulting in definite savings in weight and corresponding gains in performance. An example of this is the "Comet" jet-propelled airliner (*5*).

Perhaps the greatest disappointment of all new materials to date has been the beryllium alloys. L. B. Tuckerman pointed out in a remarkable paper about 18 years ago (*6*) that structural materials regardless of density had roughly the same value for the ratio of Young's modulus to density E/ρ, with the one notable exception of the beryllium alloys. Fig. 1 is a plot of values of E and ρ for the materials considered by Tuckerman and for a good many other materials besides. It is apparent from the figure that, with the exception of quartz, E/ρ for beryllium is more than four times as great as for the other materials. Apparently the beryllium alloys should be favored over all other materials for applications where high rigidity at minimum weight is paramount. The quantity E/ρ is also the square of the velocity of longitudinal sound waves in the material. Hence beryllium is singularly favored as an element in dynamic pickups in which the speed of response is limited by the speed of sound in the material. We may expect many applications for beryllium for small parts requiring high rigidity at minimum weight if it becomes available at relatively low cost and in a workable condition. In the meantime there is a great demand for beryllium because of its excellence as an alloying element with copper to produce spring materials with a wide elastic range and because of its importance as a neutron source in atomic-energy work.

Steel alloys retain their position in engine parts subjected to temperatures which are too high for aluminum with its relatively low melting point. But even there new materials such as the titanium alloys (*7*) challenge its position. Titanium takes the lead in the challenge with a density of only 4.5 as compared to 7.9 for iron and with a

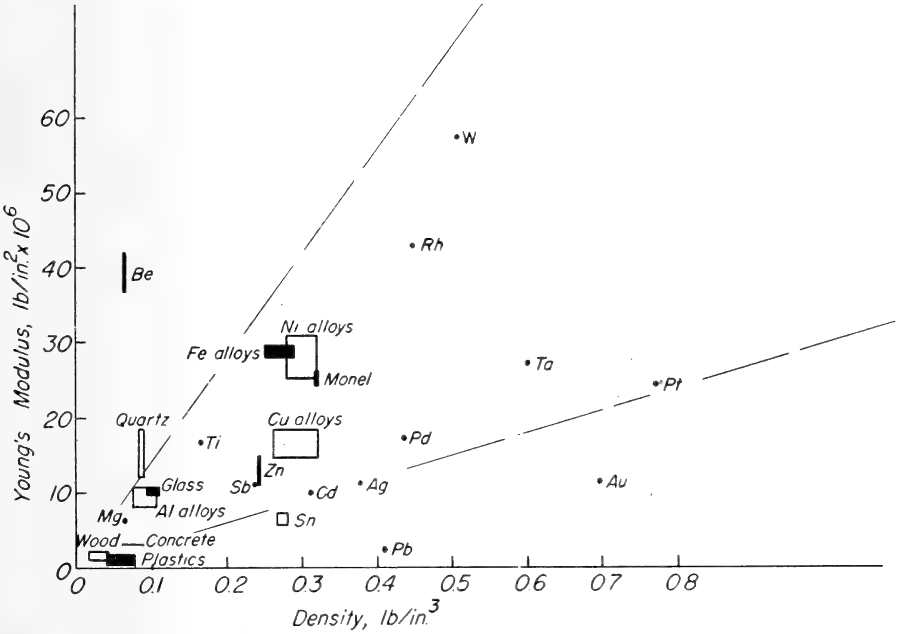

FIG. 1.—Elastic modulus and density for solid materials.

melting point of 3300°F as compared to 2800°F for iron. Ores containing titanium in combination with other elements are plentiful and the cost of producing the metal has dropped from $1,000 per pound to $5 per pound during the past five years. Titanium alloys are available now with a tensile strength of about 65,000 lb/in^2 at 800°F, which is comparable, on a strength-weight basis, to the tensile strength of special steel alloys for service at elevated temperatures, Fig. 2.

Alloys of iron, nickel, and cobalt, such as stellite and hastelloy, have been developed (Fig. 2) which retain some strength and rigidity at temperatures as high as 2000°F. (*8*). For example the tensile strength for stellite (*9*) is reported as 28,000 lb/in^2 at 1800°F.

An intensive search is going on for materials which retain some strength and rigidity at temperatures as high as 2500°F. It appears that the most promise in this field lies with the ceramels or cermets. These are sintered mixtures of powdered ceramics and metals. The ceramic provides

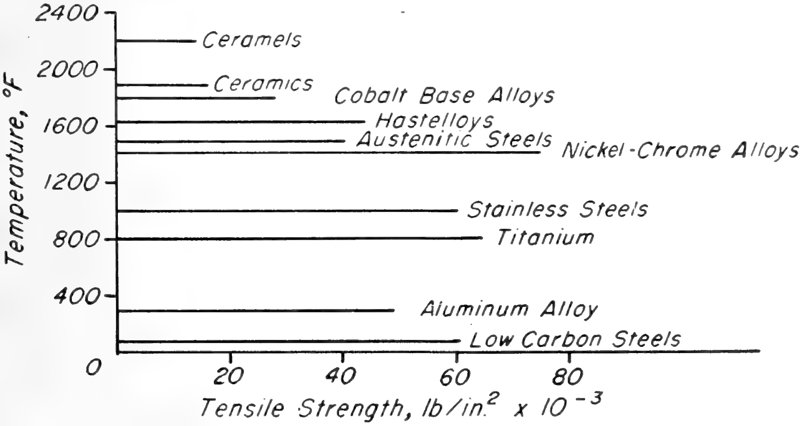

FIG. 2.—Static tensile strength of structural materials used at high temperatures.

the strength at high temperature and the metal is added to give the combination some ductility. Cermets have been reported (*10*) which have a tensile strength as high as 14,000 lb/in^2 at a temperature as high as 2200°F. We may count on great advances in this field as we learn more of the mechanism of adhesion and cohesion in sintered materials, as more combinations of materials are tried, and as better techniques of fabrication are developed.

NEW METHODS FOR DETERMINING PROPERTIES OF MATERIALS

Until a few years ago it seemed adequate to describe a material mechanically by its Young's modulus, or stiffness in tension, its yield strength, or stress at which it begins to flow appreciably, its ultimate strength, or stress for fracture; the elongation in two inches preceding fracture in tension or ductility. Today materials are used under conditions of two-dimensional stress, low temperature, high temperature, vibration and impact, and more complicated mechanical properties must be determined.

A generally adequate description of static behavior of metals at room temperature is obtained from the complete tensile stress-strain curve and the compressive stress-strain curve up to stresses well beyond the yield strength. The tensile and compressive stress-strain curves should coincide for an isotropic material; the difference between the two can be taken as a measure of anisotropy. For isotropic materials the stress-strain relations in states of combined stress can be estimated on the assumption that the octahedral stress-strain curve is independent of hydrostatic pressure (*11*). This condition has been verified for a number of materials (*12*, *13*, *14*) which were loaded under combined stress and in which the ratio of principal stresses was kept constant during the test. It is not valid if the direction of the principal stress is changed during the loading (ref. *13*, p. X9–X13).

A knowledge of the compressive stress-strain curve is of practical importance for estimating the buckling strength of columns and plates. The buckling strength is generally proportional to an effective modulus (*15*) which is a known function of the tangent modulus or slope of the compressive stress-strain curve of the material, the Young's modulus or initial slope, and, in the case of a column the shape of cross section. Approximate values of tangent modulus can be obtained for many materials by approximating the stress-strain curve with a simple formula involving three constants (*16*, *17*). Fig. 3 indicates that this formula gives a very good approximation even to stress-strain curves with a relatively sharp "knee" beyond the elastic range.

The ductility of the material is a property which is only roughly described by the elongation over a prescribed gage length. In most materials the elongation is concentrated in the region of fracture and hence the percentage elongation increases rapidly with decreasing gage length (*18*). Measurements of local elongation and of strain distribution over local regions have been made possible by photographing accurately prepared networks, or "photogrids" (*19*) on the surface of the specimen in its unstrained

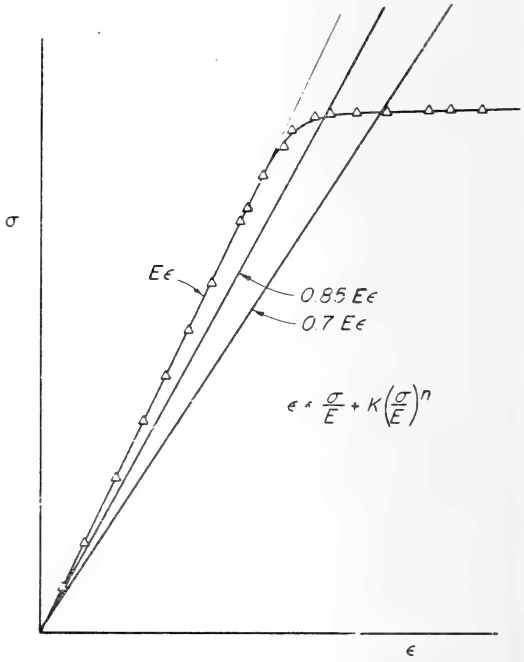

FIG. 3.—Comparison of experimental values of strain ε plotted against stress σ for 24S-T aluminum alloy (indicated by Δ) with computed curve (indicated by heavy line). Computed curve is obtained by inserting in formula given on figure values of E equal to the initial slope of the stress-strain curve and values of *K*, *n* obtained from the intersection with the empirical stress strain curve of lines with slopes equal to 0.85E and 0.70E respectively (see ref. *16*).

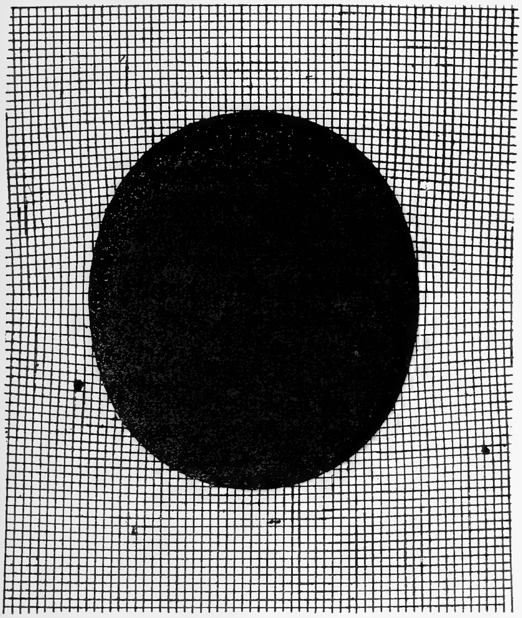

FIG. 4.—Photogrid around circular hole in tensile specimen at load near fracture load (ref. *20*).

state and observing the distortion of the network after straining the specimen up to fracture. It is likely that this technique will be exploited in the future to study strain distributions near points of strain concentration, such as that around a hole in a tensile specimen (*20*) illustrated in Fig. 4.

The dynamic behavior of materials at room temperature covers a much greater range of properties and only spot checks are possible. The elastic constants of solids under very rapid (adiabatic) loading are practically identical with those under static (isothermal) loading (*21*). Hence these constants may be determined either from static strain measurements in the elastic range or (sometimes more rapidly and conveniently) from the frequencies of known modes of vibration (*22*). The dynamic test has the advantage of giving, in addition, another property of the material, its internal friction or internal damping capacity. This may be computed from the logarithmic decrement of the vibration, from the half-width of the resonance curve, from the peak of the resonance curve, or from the decay of a pulse of ultrasonic vibrations.

The ultrasonic pulse technique is being studied in many laboratories because of its possibilities for studying the polycrystalline structure of metals as well as determining elastic constants and internal friction at elevated temperatures. As a result of this activity we can count on advances leading to improved apparatus and to more reliable interpretations of the sometimes puzzling patterns of pulses and their echoes on the receiving screen of the cathode ray tube.

Pronounced differences between static and dynamic behavior will appear as we go up along the stress-strain curve. Methods for testing metals under controlled rates of loading or of straining have been developed (*23*), but the technique is still in its infancy and there is a need for better methods which will give the stress-strain curve under dynamic conditions. Several difficulties must be overcome and these difficulties will increase as we go to very high rates of straining, rates of straining that become comparable to the velocity of propagation of plastic strain waves in the material (*24*, *25*, *26*, *27*). In the case of some important materials, such as mild steel we have to cope, in addition, with the phenomenon discovered by Clark and Wood (*28*) that yielding may require the application of the load over a definite and appreciable interval of time. Other materials, including certain plastics and rubber (*26*), show "memory" and "recovery" effects. The tests so far made indicate that the yield strength under dynamic conditions may greatly exceed the static tensile yield strength (*26*, *29*) and that the material may be less ductile than under static conditions.

Particularly great differences between static and dynamic behavior are found for the ultimate strength of metals. Metals may be "fatigued" to fracture under repeated loads at a stress as little as 40 per cent of the static tensile strength of the material. The fatigue crack or fracture originates, in general, in a region of stress concentration due to a flaw, hole, scratch, notch, or other discontinuity. The basic nature of the fatigue phenomenon is still a mystery. Fatigue seems to start by forming dislocations (*30*) on a submicroscopic scale. After many cycles of loading the dislocations grow and coalesce into minute cracks.

Only the last stage of the failure is visible. During this last stage one or more of the small cracks spreads through the structure, unless stopped by a reduction in stress, until the structure breaks completely.

Repeated loads are common in the operation of modern machinery, perhaps more common than steady loads, and fatigue failure has become the most common type of failure in service. It is also the most aggravating since the "fatigue strength" of a structure cannot be predicted from the fatigue strength of the material with the same accuracy as the static strength of a structure can be predicted from the static strength of the material. The fatigue strength of materials is estimated by subjecting a large number of specimens to alternating axial stress, bending stress, or torsional stress of constant amplitude and determining the number of cycles to failure for each amplitude of stress. The tests are time-consuming in that they require far more specimens than static tests and usually more testing time per specimen. An appalling amount of fatigue testing is going on in the mechanical testing laboratories of the earth, but the data obtained from these tests do little more than tell us that one material has greater or smaller fatigue strength than another. The data tell us little of the mechanism of fatigue failure and they do not answer the practical question of how to predict fatigue failure in a structure from the fatigue strength of the material. The engineering fraternity is much disturbed by this shortcoming in our testing techniques and much work is under way to study the phenomenon of fatigue failure on the one hand (*31*) and to devise new fatigue tests, which can be tied in with service conditions (*32*), on the other. We can hope to see within the next decade or two, methods for determining fatigue damage on a given material and methods for accelerated fatigue test. We can expect to see more methods for fatigue tests under variable stress amplitude, under combined stress, and in the presence of a known stress concentration.

At least as puzzling as the fatigue strength of materials is their strength under shock loads. These are defined as loads which vary appreciably during a time interval comparable to the time required by elastic waves to spread through the body. Shock loads, like alternating loads, may lead to premature failure at a point of stress concentration. The resistance of materials to shock loads is usually determined from the energy required to fracture, by transverse impact, a specimen with a standard notch (Fig. 5) such as a Charpy, an Izod, or a Schnadt specimen. The mechanics of this test is complicated and unsuitable for analysis. There is a need for the development of a shock test with a much more clearly defined state of stress.

The range of properties of materials of interest is increased if operating temperatures other than room temperature have an important effect. At low temperatures certain metals such as mild steel (*33*) and zinc become brittle and notch sensitive. This property is usually determined by tear tests on specimens with prescribed notches (*34, 35*) or by transverse notched-bar impact tests on notched bars over a range of temperatures. Brittleness at low temperature shows up in transverse impact tests by a rapid transition from appreciable values of impact energy to very low values as the temperature is decreased. Unfortunately,

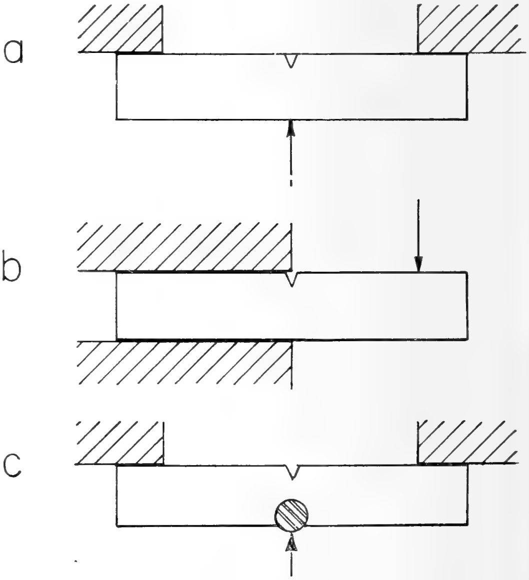

FIG. 5.—Transverse impact specimens: a, Charpy; b, Izod; c, Schnadt.

the "transition temperature" indicated by these tests depends not only on the material, but also on the stress concentration around the notch. It rises, in general, with increasing stress concentration (*36*).

At elevated temperatures creep appears as an additional material property to confound the user of metals. Creep can be disregarded in measurements at elevated temperatures only if the strains are applied very rapidly. This puts a premium on the determination of elastic constants at high temperatures by measurements of natural frequency of a mode of vibration or of the speed of propagation of ultrasonic pulses (*37*). Under more sustained loads the strain due to creep may be comparable or even greater than the strain produced by the first application of the load. Creep like fatigue is a field where a great deal of testing has been done but, so far, it has not been possible to fit these data into a theory which would enable one to determine the creep in a structure from the load-time-temperature program of the structure and the creep properties of the material. Most creep tests are made today in tension and in torsion (ref. *38*, pp. 45–49). These have generally shown three stages of creep, Fig. 6, a first stage of rapid transient creep, a second stage of sustained linear creep, and a third stage of accelerated creep to failure. In the field of creep, as in the field of fatigue, we may expect distinct advances during the next decade both in our understanding of the phenomena and in the development of accelerated creep tests and tests in the presence of stress gradients.

In all this work of determining the properties of materials under combined stresses, at elevated temperatures, under oscillatory loads and under impact loads, one is faced with the problem of eliminating the effects of other variables such as variations in properties and dimensions of nominally identical specimens, variations in testing machines, and differences in the technique of the persons making the tests. Careful selection of the specimens and careful planning of the test schedule are required to eliminate the effect of the extraneous variables as far as possible. Statisticians have been concerned with this problem of "randomizing" tests for some years and they have worked out definite procedures (*39*, *40*). The possibilities of obtaining adequate test results with fewer specimens by these statistical procedures are being realized increasingly. Ultimately they should lead to the consulting of statistically trained engineers in the planning stages of any extensive test program on properties of materials.

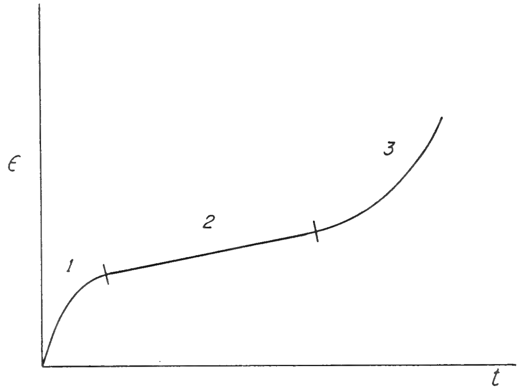

FIG. 6.—Schematic of strain ϵ due to creep under constant load as a function of time t.

NEW METHODS OF DESIGN

Design can be regarded as the utilization of material with known properties to accomplish a given task such as the transmission of known forces in the operation of a piece of equipment or structure. The structure is designed efficiently if its weight is reduced to a minimum compatible with adequate performance throughout its service life. Efficient design is important in bridges, vehicles, and ships, but it is of paramount importance in aircraft where every pound of structural material saved adds a pound to the pay load. The needs for precise stress analysis in aircraft design are responsible for most present-day applications of the theory of elasticity and they have inspired a phenomenal growth in the number of new contributions to elastic theory and in the number of text books and treatises on this subject. Most present day design is based on the assumption that the material is elastic and follows Hooke's Law, tempered by the recognition that high stress concentration near points of contact and around notches will be reduced by local yielding at these points. Stress analysis under these conditions is the principal topic in textbooks on the strength of materials. It is a major activity in the design offices of aircraft companies, bridge builders, and structural designers in general. It has the supreme virtue of linearity so that the stress components due to various systems of loads can be superposed. This makes it possible to build up complicated solutions from simple elements and makes it convenient to apply computing machines, which are adapted most readily to the solution of linear systems.

Linearity disappears as we leave the elastic range and go into the plastic range. It is not surprising, therefore, that we are only beginning to cope quantitatively with plastic yielding in structural design. The foundations were laid by Nadai (*41*) in his classic book on "Plasticity" published twenty years ago. Most present day applications are confined to an ideal plastic material which is elastic up to the yield strength and then yields indefinitely at that stress (Fig. 7). Fortunately for structural engineers, structural steel approaches this idealized stress-strain relation. Thus it has been possible to take account of certain types of plastic yielding in steel structures by the "limit design" or "plastic hinge design" procedures of Van den Broek (*42*), J. F. Baker (*43*), Wm. Prager (*44*), and their associates. By these methods it is now possible to estimate the capacity of steel frame structures to sustain loads and to absorb energies during explosions (*45*) far in excess of those given by the conventional linear stress analysis. A particularly successful example of "plastic hinge" design is the Morrison air raid shelter constructed in large numbers in Great Britain during World War II. This consists of a 2.5 by 4 by 6.5 ft. box framed by angle section beams rigidly joined at the corners and covered with a ⅛-inch steel plate on the top and with a mesh of steel wires or strips on the bottom and the sides. The shelter is designed to withstand not only collapse against the loads imposed by falling debris but also against permanent deflection beyond a point at which the occupants of the shelter would be in danger of being crushed. Reference *46* contains descriptions of spectacular instances in which this shelter saved lives by behaving plastically as intended during the destruction by bombing of the house in which it was located.

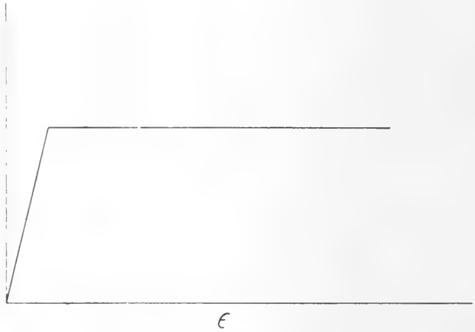

FIG. 7.—Stress strain curve for ideal plastic material.

The theoretical bases for estimating plastic flow and fracture in more complicated and more general cases have been studied thoroughly by a group of mathematicians working under Prof. Wm. Prager's direction at Brown University (*47*). A great deal of experimental work must be done during the next few years to test their conclusions and to make them of practical use for design.

Design procedure may be affected basically by this work on plastic flow of solids in so far as it has shown that it is shear stresses rather than tensile stresses that are primarily responsible for deformation. Shear stresses are more important in the elastic range as well. Hetenyi (*48*) has pointed out how much more damaging shear stresses are than normal stresses in the contact and friction between two solid bodies and he has even proposed an ingenious procedure for estimating stress concentration factors around notches in elastic rods under axial load by considering the shear stresses only. All this may lead ultimately to a shift from tensile stress to shear stress as the principal quantity to be computed in the stress analysis of structures.

Further complications appear in design when we bring in time as a variable in designing against creep, as in a turbine operating at elevated temperature. In such machines it is essential that the creep during the lifetime of the machine should be small enough to maintain a safe clearance between stationary and moving parts. Design against creep is generally based on the rate of creep during the second or "linear" stage (Fig. 6). More refined methods taking account of the transient creep during the first stage have been proposed by Nadai (*49*) and Odqvist (*50*). We may expect further development along these lines during the coming years since creep will become of increasing importance as materials have to be used at temperatures closer to their melting point. This will create a demand for design procedures which allow for creep under tensile, compressive, and combined stresses, and in the presence of stress concentration.

But the greatest advances in design procedures are to be looked for in the design against fatigue failure, i.e., failure under alternating loads. Service failures have taught us the very important lesson to avoid as far as possible any stress concentrations by a notch, a hole, or sudden change in section as these might favor the initiation of a fatigue crack. However, we are still far from a quantitative understanding on which a design procedure could be based, except for isolated cases such as ball and roller bearings (*52*). As mentioned above we know too little about the factors that control the start and the finish of the fatigue crack. We know that both are subject to large statistical variations even under ideal laboratory conditions. In service the conditions are far from ideal and there are large uncertainties in the loads to which the structure is subjected.

It is clear that the difficulties are great, but the challenge of working out an adequate method for design against fatigue failure is perhaps the greatest challenge in mechanical design, since fatigue failures predominate among mechanical failures in service.

An adequate design procedure against fatigue failure would have to start from a knowledge of the loads imposed on the structure during its service and would consist of computing the response of the structure to these loads and then estimating its "life" in the presence of this response.

Strain, acceleration, and displacement pickups for measuring loads in service are coming on the market in increasing numbers. A prodigious volume of data under service conditions is being accumulated with these pickups. These data remain to be digested, with the help of statistics, to give an adequate picture of loads in service.

Fortunately, the picture looks brighter when it comes to computing the response of a structure to impact loads. The procedures in this field have been well developed thanks to the work of Biot (*53*), Bisplinghoff (*53*), and others (*54*, *55*).

The problem is treated as one more case of the transient response of a structure regarded as a linear system (*56*). The response is usually computed in terms of the normal modes of vibration of the system which are excited by the impact. This in turn has put a new incentive behind the solution of normal modes by rapidly converging numerical methods such as the matrix iteration method of Duncan and Collar (*57*). A tremendous field remains to be cultivated to accomplish the last phase, the estimate of the life of the material under the imposed cycles of stress.

I have mentioned the application of statistics in the design against fatigue failure. There are many other applications of statistics in design. Statistics should be used in estimating the probable life of a structure just as it is used to estimate our personal life span for the computation of our life insurance premium. Statistics provides the only rational basis for estimating margins of safety against failure. For example, it enables one to estimate the probability of failure of a part subjected to loads P with a scatter described by $p_1(P)$

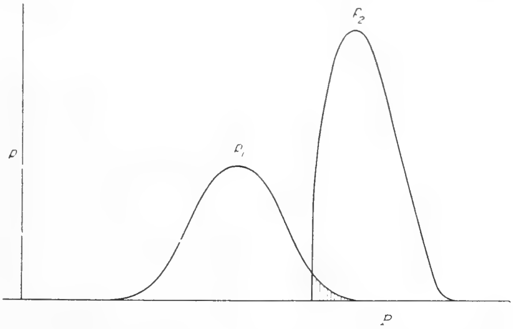

FIG. 8.—Schematic distribution p_1 of load P acting on structural element in service and distribution p_2 of strength P of element.

when the strength of the part under this type of load is described statistically by $p_2(P)$, Fig. 8. The probability of failure in a given period of time is then proportional to

$$\int_0^\infty p_1 \left[\int_0^P p_2 \, dP \right] dP.$$

Statistics provides the only sound estimate for the probability that a given complicated mechanism, such as a missile, consisting of elements each with their own characteristic scatter of properties, will function as a whole in service. For all these reasons we may expect a large scale invasion of design procedures by statistical considerations. Designers in general should become conscious of the basic function of statistics in placing their estimates on a sound basis, properly related to the scatter in the external loads and in the properties of the material.

I have said nothing about one class of design problem that has fascinated mathematicians, physicists, and engineers from the days of Euler in 1793, that is, the problem of instability, whether static as in columns or dynamic as in flutter. This problem will continue to engage the attention of the best brains among us and we can count on specific solutions for much more complicated structures as the new high speed computing machines are drafted for the laborious computations that are involved (*58*). Solutions by the mathematical theory of elasticity for the stresses at the base of notches (*59*) or near a hole in a shaft or structure have taken on added practical value with the realization that these stresses are a major factor in determining fatigue strength.

Another class of problems which has not been mentioned, but which is nevertheless on the minds of the best analytical talent in mechanics is that of the nonlinear phenomena in mechanics. Von Karman has given an excellent exposition of some of these problems and of the special techniques developed to cope with them in his notable paper entitled "The engineer grapples with nonlinear problems" (*60*). Practically any physical phenomenon becomes nonlinear as one refines its analysis beyond the first approximation. The elastic stress-strain relation becomes nonlinear when the strains are no longer negligibly small compared to 1, as in the case of rubber. Resonant vibrations frequently lead to amplitudes that are far from infinitesimal, consequently the resonance curve may deviate greatly from the classical shape based on the linear theory. Phenomena such as the buckling of thin shells, the bowing of a violin string, water hammer, the galloping of a transmission line loaded with sleet, can not be explained even qualitatively without taking account of the nonlinear relation between the exciting forces, restoring forces, and friction forces involved. Nonlinear phenomena plague us also in the analysis of control systems which have small but definite amounts of backlash or play in them. Very few of these problems can be solved with any generality because of the nonlinearity and complexity of the equations for the problem. A great deal of numerical computation is usually required to get a specific solution for a given set of conditions. The more general solutions confine themselves to questions such as the determination of boundaries between stable and unstable operation in a given system (*61*).

The chances for general analytical solutions are diminished still further if we deal with problems which require more than one differential equation for their description. An example is the phenomenon of plastic impact (*62*) in which we have to deal simultaneously with advancing and reflected waves, which cannot be superposed as in the elastic range. In such problems we can expect little more, for years to come, than specific solutions by numerical methods of specific relatively idealized cases which can be checked in the laboratory.

I have said nothing about an entirely different field of design, the field of biomechanics. Biomechanics appears unconsciously in all our thinking because we have through thousands and tens of thousands of generations adapted ourselves to the mechanical forces about us such as the force of gravity. As stated so eloquently by d'Arcy Thompson (*63*):

> Gravity not only controls the actions, but also influences the forms of all save the least of or-

ganisms. The tree under its burden of leaves or fruit has changed its every curve and outline since its boughs were bare, and a mantle of snow will alter its configuration again. Sagging wrinkles, hanging breasts and many another sign of age are part of gravitation's slow relentless handiwork.

We realize that modern civilization imposes upon man forces that were unknown to him three generations ago, and we know that these forces are sometimes too much for him. We can predict that the field of biomechanics is in for a great expansion because the designers of modern equipment, particularly aircraft operating at high speeds and accelerations, are becoming increasingly concerned with man's limitations as the guiding operator in a machine, his finite time of response, the limits to his vision, his finite dimensions, his need for oyxgen, his abhorrence of acceleration, and his many other limitations as a pilot.

TESTS

The development of a new design must be accompanied by tests at many stages along the way to check on the predictions of the analysis which is based on simplifying assumptions. The first tests are made on coupons cut from the material to determine mechanical properties. Next there are tests of simple components of the structure, the simple beams, struts, plates, hinges, to check on the stress distribution and strength of these elements.

A vigorous new field of engineering, termed experimental stress analysis, has organized itself during the past ten years to cultivate the many special techniques required for this purpose. For many years photoelasticity was the leading technique for the experimental stress analysis of elements that were too complicated for a theoretical stress analysis. Strain gages, such as the Tuckerman strain gage, were used to measure strains on the structure itself particularly in cases in which photoelastic models could not be used because of the limitation of photoelasticity, as then known, to two-dimensional states of stress inside the elastic range. Unfortunately, strain gages were usually too limited in number and too cumbersome to be used at many points of a structure.

All this changed with the arrival of the wire strain gage about ten years ago. The wire strain gage (Fig. 9) is nothing more than a fine wire which is glued to the structure and is strained along with the structure. The wire changes resistance in proportion to the strain and this change in resistance may be amplified and recorded. The wire strain gage is small, light, and inexpensive. It may be fastened by the hundreds to a complicated structure to measure strain on that structure as it is proof loaded. Its lightness and consequent lack of inertia together with its electrical output makes the wire strain gage a nearly ideal pickup for dynamic

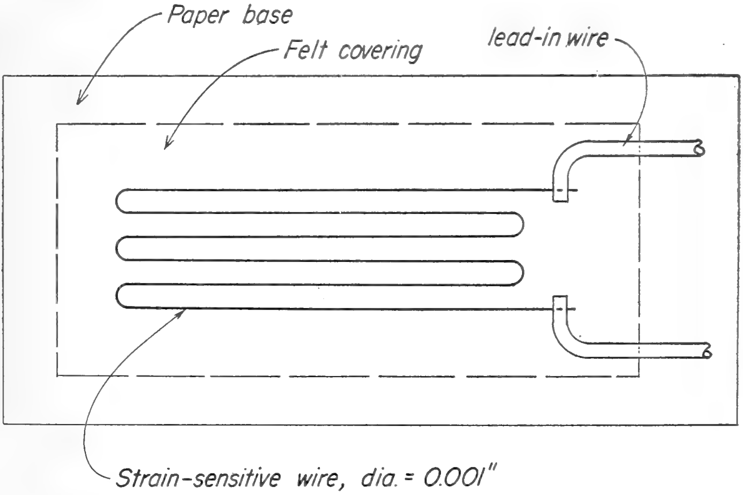

Fig. 9.—Construction of wire resistance strain gage.

measurements, such as strain and vibration measurements, on engines in operation, on aircraft in flight, on structures under impact. It is not surprising, in view of all these advantages that the consumption of wire strain gages is of the order of magnitude of one million per year.

The wire strain gage has a few serious shortcomings. Its output is small and requires expensive apparatus for amplification. Its resistance changes appreciably over long periods of time because of creep in the bonding medium. The resistance of most wire strain gages changes with changes in temperature. No adequate method is known to calibrate an individual gage and hence establish the precision with which strain is measured with it. Most gages fail to function at elevated temperatures, again because of creep in the bonding medium. Investigations are under way here and abroad to improve the wire strain gage in all these respects and to develop gages which can be used far beyond the elastic range. Evaporated coatings of carbon and of metals are being studied (*64*) because of their promise to provide us with strain gages of very large output and gages which will function at high temperatures.

Major improvements are also well under way in the field of photoelasticity. It is possible now to determine stress distributions for three-dimensional as well as two-dimensional states of stress by using the "freezing technique" (*65*). Some years ago Hetenyi (*66*) tried out this technique on an important three-dimensional problem, the stress distribution in bolts with various threads. Recently Leven (*67*) and Frocht (*68*) showed that excellent results can be obtained with the technique using certain relatively inexpensive new plastics.

Qualitative surveys of strain distribution on structural elements are often possible by coating the element with a brittle lacquer (ref. *38*, pp. 636–662) and observing the crack pattern in the lacquer as the element is subjected to load. We can count on improvements in this technique and its extension to strain surveys at high temperatures as the characteristics of existing coating materials are controlled more closely and as new ceramic coatings are tried out (*69*).

After checking on the structural elements, these are assembled into more complicated structures, such as built-up beams, airplane wings and fuselages. The structures generally undergo a proof test, usually under static loads to check on the design up to that stage. Certain structures such as landing gear of aircraft are drop-tested; others subject to vibration in service, are tested under alternating loads for 50,000 or more cycles to indicate any weaknesses which might lead to premature fatigue failure.

Finally the complete structure is assembled from its major components and it goes through a series of tests under service conditions. We have the shake-down cruises for ships and test flights for aircraft to show up weaknesses that escaped notice in the laboratory tests.

Some weaknesses will not develop until after a long period of service. Hence a careful investigation should be made of any failures in service of a structure, such as an airplane, a crankshaft or a ship's hull, in order to prevent similar failures in the future. The failed structure should be examined for clues which might establish the sequence of causes and effects leading to the failure. Tests should be made on the parts to check the structure for weaknesses in the material or in the design. The value of this sort of autopsy is being realized increasingly and several collections (*51*, *70*, *71*) of typical service failures have been assembled to aid the engineer in this detective work.

Service failures have been traced down occasionally, though rarely, to internal cracks or flaws in the material. This, in turn, leads to a demand for inspecting a large number of similar structures for the presence of flaws. Inspection is possible today by several techniques, leading among them is the magnetic powder method (*72*), radiography (*73*) with high voltage X-rays or other sources of penetrating radiation, and the use of ultrasonic pulses (*74*). Many of the inspection methods, such as the magnetic induction method to inspect tubes for flaws (*75*), have found their way into the producers' plants and their adoption has, no doubt, greatly reduced the number of cases in which failures can be traced to faulty material. As mentioned earlier, the most common mechanical cause of failure appears to be not faulty material, but inadequate design against fatigue failure.

CONCLUSION

We have seen that mechanics is far from being a dead science. It has many frontiers and many problems to solve. Most of the problems come from the demands of combat. It was that way from the time of the first bowman through Leonardo da Vinci to the present day of conflict on a global scale. However, the benefits of mechanics transcend the immediate needs of war. They are at the basis of our prosperity. The war planes of yesterday lead to the passenger planes to today. Lamé's (*76*) equations for designing gun barrels to withstand the internal pressure of the powder blast provided us with a basis for designing pressure vessels of other types for use by the chemical industry. The solution of almost any wartime need may bear fruit someday in peacetime. It is for this reason that most of us working in the field of mechanics feel that we have a real part to play in bettering the material standards of our civilization, even though most of our salaries may come directly or indirectly from the demands for national defense.

REFERENCES

(1) LOVE, A. E. H. *The mathematical theory of elasticity*, 4th ed. Cambridge University Press, 1934.

(2) BUCKLEY, H. *A short history of physics*. London, 1929.

(3) DE BRUYNE, N. A., AND HOUWINK, R. (ed). *Adhesion and adhesives*. Amsterdam, 1951.

(4) *Sandwich Construction for Aircraft: Part 4, Fabrication, inspection, durability and repair.* Issued by Subcommittee on Air Force-Navy-Civil Aircraft. Design Criteria of the Munitions Board Aircraft Committee, 120 pp. Washington, 1951.

(5) POVEY, H. *Planning and production methods used in the construction of the De Havilland Comet*. Journ. Roy. Aeron. Soc. **55:** 459–517. Aug. 1951.

(6) TUCKERMAN, L. B. *Aircraft materials and testing*. Edgar Marburg Lecture. Proc. Amer. Soc. Test. Mat. **35:** (pt. 2): 46 pp. 1935.

(7) *The Titanium Seminar*. Report of Engineer Research and Development Laboratories, 95 pp. Fort Belvoir, Aug. 1952.

(8) VAN ECHO, J. A., PAGE, L. C., SIMMONS, W. C., CROSS, H. C. *Short-time creep properties of structural sheet materials for aircraft and missiles*. U. S. Air Force Tech. Rep. 6731 (pt. 1): 65 pp. Aug. 1952.

(9) PRESTON, D. *Exploratory investigation of high temperature sheet materials*. Amer. Soc. Test. Mat. Preprint 85. 1952.

(10) BOBROWSKY, A. R. *The applicability of ceramics and ceramels as turbine blade materials for the newer aircraft power plants.* Trans. Amer. Soc. Mech. Eng. **71:** 621–629, 1949.

(11) NADAI, A. *Theories of strength*. Amer. Soc. Mech. Eng. Trans. App. Mech. **1**(3): 111–129. 1933.

(12) OSGOOD, W. R. *Combined stress tests on 24 S-T aluminum alloy tubes*. Journ. Appl. Mech. **14:** A147–A153. June 1947.

(13) DRUCKER, D. C. *Stress-strain relations in the plastic range—A survey of theory and experiment*. Brown Univ. Rep. Contr. N7onr-358 T.O.I. NR-041-032. Dec. 1950.

(14) RAMBERG, W., AND MILLER, J. *Stress-strain relation in shear from twisting test of annulus*. Nat. Bur. Standards Journ. Res. **50:** 2, R.P. 2389. Feb. 1953.

(15) TIMOSHENKO, S. *Theory of elastic stability*: 156–165, 384–390. New York, 1936.

(16) RAMBERG, W., and OSGOOD, W. R. *Description of stress-strain curves by three parameters*. Nat. Adv. Comm. Aeron. Tech. Note 902: 13 pp. July 1943.

(17) OSGOOD, WILLIAM R. *Stress-strain formulas*. Journ. Aer. Sci. **13** (1): 43–48. Jan. 1947.

(18) MILLER, JAMES A. *Stress-strain and elongation graphs for Alclad Aluminum alloy 24S-T86 sheet*. Nat. Adv. Comm. Aeron. Tech. Note 2094: 31 pp. May 1950.

(19) BREWER, GIVEN A., and GLASSCO, ROBERT B. *Determination of strain distribution by the Photo-grid process*, Journ. Aer. Sci. **9**(1): 1–7. Nov. 1941.

(20) MILLER, JAMES A. *Improved photogrid techniques for determination of strain over short gage lengths*. Proc. Soc. Exp. Stress Analysis **10**(1): 29–34. 1952.

(21) POYNTING, J. H, and THOMSON, J. J. *Heat:* 302–305. London, 1906.

(22) FINE, M. E. *Dynamic methods for determining elastic constants and their temperature in metals*. Symposium on Determinations of Elastic Constants. ASTM Special Tech. Publ. 129: 43–67. 1952.

(23) CLARK, D. S., and DUWEZ, P. E. *The influence of strain rate on some tensile properties of steel*. Proc. Amer. Soc. Test. Mat. **50:** 560–576. 1950.

(24) DUWEZ, P. E., and CLARK, D. S. *An experimental study of the propagation of plastic deformation under conditions of longitudinal impact*. Proc. Amer. Soc. Test. Mat. **47:** 502–522, discussion 523–532, 1947.

(25) CAMPBELL, W. R. *Determination of dynamic stress-strain curves from strain waves in long bars*. Presented before Soc. Exp. Stress Analysis, May 1951 (to be published).

(26) KOLSKY, H. *An investigation of the mechani-*

cal properties of materials at very high rates of loading. Proc. Phys. Soc. (B) **62:** 676–700. 1949.

(27) Campbell, J. D. *An investigation of the plastic behaviour of metal rods subjected to longitudinal impact.* Journ. Mech. and Phys. Solids **1:** 113–123. Jan. 1953.

(28) Clark, D. S., and Wood, D. S. *The time delay for the initiation of plastic deformations at rapidly applied constant stress.* Proc. Amer. Soc. Test. Mat. **49:** 717–737. 1949.

(29) Campbell, W. R. *Dynamic stress-strain curves for mild steel using the tangent modulus procedure.* Journ. Washington Acad. Sci. **43:** 102–103. 1953.

(30) Machlin, E. S. *An application of dislocation theory to fracturing in fatigue.* Proc. A.S.M. Chicago Seminar 1947: 282–289. Cleveland, 1948.

(31) Peterson, R. E. *Review of the fatigue of materials field.* Rev. Appl. Mech. **5:** 1–3. Jan. 1952.

(32) Smith, F. C., Howard, D. M., Smith, Ira, and Harwell, R. *Fatigue testing machines for applying a sequence of loads of two amplitudes.* Nat. Adv. Comm. Aeron. Tech. Note 2327. March 1951.

(33) Williams, M. L. *Brittle fractures in ship plates.* Nat. Bur. Standards Circ. 520 on Mech. Prop. Metals at low Temp.: 180–206. May 1952.

(34) Kahn, Noah A., and Imbembo, Emil A. *Notch sensitivity of steel evaluated by tear test.* Welding Res. Suppl. **14**(4): 153S–165S. April 1949.

(35) Vanderbeck, R. W., and Gensamer, M. *Evaluating notch toughness.* Welding Journ. **29**(1): Research Suppl.: 37S–48S. Jan. 1950.

(36) Stout, R. D., and McGrady, L. J. *The meaning and measurement of transition temperature.* Welding Journ. Res. Suppl. **27**(6): 299S–302S. 1948.

(37) Schneider, William C., and Burton, Charles J. *Determination of the elastic constants of solids by ultrasonic methods.* Journ. Appl. Phys. **20:** 48–58. Jan. 1949.

(38) Hetenyi, M. *Handbook of experimental stress analysis:* 1077 pp. New York, 1950.

(39) Cochran, Wm. G., and Cox, Gertrude. *Experimental designs:* 454 pp. New York. 1950.

(40) Wilson, E. B., Jr. *An introduction to scientific research:* 375 pp. New York, 1952.

(41) Nadai, A. *Plasticity.* New York, 1931.

(42) Van den Broek, J. A. *Theory of limit design:* 144 pp. New York, 1948.

(43) Baker, J. F., Roderick, J. W., and Horne, M. R. *Plastic design of single bay portal frames.* Brit. Weld. Res. Ann. Rep. FE 1/2: 24 pp. Aug. 1947.

(44) Symonds, P. S., and Prager, W. *Elastic-plastic analysis of structures subjected to loads varying arbitrarily between prescribed limits.* Journ. Appl. Mech. **17**(3): 315–323. Sept. 1950.

(45) Newmark, N. M. *Analysis and design of structures subjected to dynamic loading.* Univ. Illinois Civ. Eng. Studies, Struct. Res. Ser. 37. Nov. 1952.

(46) Baker, J. F. *Plasticity as a factor in the design of war-time structures.* The Civil Engineer in War, Inst'n. of Civil Engineers, **3:** 30–52. London, 1948.

(47) Prager, William. *Recent developments in the mathematical theory of plasticity.* Journ. Appl. Phys. **20**(3): 235–241. Mar. 1949.

(48) Hetenyi, M. *Investigation of the effects of surface shear loadings.* Techn. Inst. Northwestern Univ. Interim Report. July 1952.

(49) Nadai, A. *Strain hardening and softening with time in reference to creep and relaxation in metals.* Amer. Soc. Mech. Eng. Advance Paper 50- A121 for meeting Nov.–Dec. 1950, 24 pp.

(50) Odqvist, F. K. G. *Influence of primary creep on stresses in structural parts.* Paper presented before 8th International Congress for Applied Mechanics, Istanbul, August 1952.

(51) Staff of Battelle Memorial Institute. *Prevention of the failure of metals under repeated stress.* New York, 1941.

(52) Lundberg, G., and Palmgren, A. *Dynamic capacity of roller bearings.* Acta Polytechnica **96:** 32 pp. 1952.

(53) Biot, M. A., and Bisplinghoff, R. L. *Dynamic loads on airplane structures during landing.* Nat. Adv. Comm. Aeron. Wartime Report W-92. Oct. 1944.

(54) Ramberg, Walter. *Transient vibration in an airplane wing obtained by several methods.* Journ. Res. Nat. Bur. Standards **42:** 437–447. 1949.

(55) Pian, T. H. H., and Flomenhoft, H. I. *Analytical and experimental studies on dynamic loads in airplane structures during landing.* Journ. Aeron. Sci. **17:** 765–774. 1950.

(56) Levy, Samuel. *Computation of influence coefficients for aircraft structures with discontinuities and sweepback.* Journ. Aero. Sci. **14**(10): 547–560. Oct. 1947.

(57) Duncan, W. J., and Collar, A. R. *A method for the solution of oscillation problems by matrices.* Phil. Mag. **115:** 865–900. May 1934.

(58) Levy, S. *Influence coefficients of tapered cantilever beams computed on SEAC.* Journ. of Appl. Mech. **20**(1): 131–133. March 1953.

(59) Neuber, H. *Kerbspannungslehre.* Berlin, 1937. (See also Translation 74, David Taylor Model Basin, 180 pp. Nov. 1945.)

(60) Karman, Th. von. *The engineer grapples with non-linear problems.* Bull. Amer. Math. Soc. **46**(8): 615–683. Aug. 1940.

(61) Minorsky, N. *Introduction to non-linear*

mechanics. David Taylor Model Basin Reports 534, 546, 558, 564. 1944–46.

(62) Lee, E. H., and Wolf, H. *Plastic wave propagation effects in high speed testing.* Brown Univ. Grad. Div. Appl. Math. Tech. Rep. 48, 33 pp. April 1950.

(63) Thompson, d'Arcy Wentworth. *On growth and form:* 1116 pp. Cambridge University Press, 1948.

(64) Campbell, W. R. *A preliminary investigation of the strain sensitivity of conducting films.* Proc. Nat. Bur. Standards Symposium on resistance strain gages. Nov. 1951. (To be published as NBS Circular.)

(65) Frocht, M. M. *The growth and present state of three-dimensional photoelasticity.* Applied Mech. Rev. **5**(8): 337–340. Aug. 1952.

(66) Hetenyi, M. *A photoelastic study of bolt and nut fastenings.* Journ. Appl. Mech. **10**(2): 93. June 1943.

(67) Leven, M. M. *A new material for three-dimensional photoelasticity.* Proc. Soc. Exp. Stress Analysis **6**(1): 19–28. 1948.

(68) Frocht, M. M. *A new cementable material for two- and three-dimensional photoelastic research.* Presented at 8th International Congr. Theor. Appl. Mech. Istanbul, Turkey, Aug. 1952.

(69) Singdale, F. M. *Improved brittle coatings for use under widely varying temperature conditions.* Presented before Soc. Expr. Stress Analysis, New York, Dec. 1952.

(70) Lipson, C. *Why machine parts fail.* Machine Design **22**(5): 95–100, May 1950; (6) 111–116, June 1950; (7) 141–145, July 1950; (8) 157–160, Aug. 1950; (9) 147–150, Sept. 1950, (10) 97–100, Oct. 1950; (11) 158–162, Nov. 1950; (12) 151–156, Dec. 1950.

(71) Wyss, Th. *Die Sachschaeden an Motorfahrzeugen:* 418 pp. Zurich, 1951.

(72) Doane, F. B., and Mages, M. *Magnaflux procedures.* Iron Age **149:** 47–52, Mar. 12, 1942; 56–58, Mar. 19, 1942.

(73) Carpenter, O. R. *Some results of advances in welding and radiography on the welding of pressure vessels.* Welding Journ. **25**(6): 531–542. June 1946.

(74) De Lano, Ralph B. *Supersonic flaw detector.* Electronics **19**(1): 132–136. Jan. 1946.

(75) Knerr, H. C. *Electrical detection of flaws in metals.* Metals and Alloys **12**(4): 464–469. Oct. 1940.

(76) Lamé. *Leçons sur la theorie d'elasticité.* Paris, 1852.

ENTOMOLOGY.—*New tabanid flies of the tribe Merycomyiini.* Alan Stone, U. S. Bureau of Entomology and Plant Quarantine.

The tribe Merycomyiini (Diptera) was proposed by Philip (Can. Ent. **73:** 4. 1941) to include the single genus *Merycomyia* Hine, 1912. This genus contains two described species from eastern United States, *M. mixta* Hine and *M. whitneyi* (Johnson). The purpose of the present paper is to describe from the collection of the U. S. National Museum two new species of *Merycomyia* and a new genus and species in the tribe.

The tribe Merycomyiini falls into the subfamily Pangoniinae because the hind tibiae each bear a pair of spurs, although in the genus *Merycomyia* these are reduced in size. The tribe is separated from other members of the Pangoniinae by having only three flagellar segments in the antenna.

Merycomia haitiensis, n. sp.

Figs. 1a–c

Predominately brown species of medium size; frons broad, distinctly narrowed above.

Female: Length 17 mm, wing 14.5 mm. Head grayish brown with darker brown hairs. Frons as high as width at lower margin of eyes; width at vertex about 0.8 width below. Eyes with dense, short hair, when relaxed uniformly green. Ocelli on a prominent tubercle, the hairs behind the tubercle somewhat stouter, curving forward: frontal callus diamond-shaped, about 0.4 width of frons; a very slender darker line extends dorsally, about halfway to ocelli. Subcallus distinctly swollen, yellowish brown, this and the upper part of genae without hairs; a distinct median groove from lower angle of callus to interantennal area. Genae and clypeus with long dark hair. Antenna: Scape and pedicel both grayish brown, short, stout, with long black hairs; flagellum orange brown, with a few short hairs; first segment about twice as long as broad, the dorsal margin nearly straight, the ventral margin distinctly convex; second and third segments subequal, the third tapering. Palpus short and stout, the first segment subglobular, the second swollen, and curved to an acute apex; both with long hairs. Proboscis less than 1 mm long, the labellae large. Dorsum of thorax reddish brown and grayish, subshining, the gray forming five narrow stripes, the outermost one on each side dividing just behind the transverse suture; humeri yellowish; sides of scutellum paler than middle; pleura brown; hairs of thorax dark brown to blackish. Halteres light brown. Wings pale brown all the veins broadly margined with dark brown, venation unmodified. Legs uniformly yellow-brown, with brown hairs; hind tibial spurs small but distinct, dark. Abdomen dark brown, the sides of segment one and basal half of tergite four grayish brown; hairs mostly blackish brown, with some admixture of paler hairs.

Holotype, female, U.S.N.M. no. 61675.

Type locality: Haitien. (This is presumably Cap Haitien on the north coast of Haiti.)

The only other data on this specimen are "June 25/28" and the number 5. The collector is unknown. The shape of the frons and frontal callus distinguish this from all other known species of the genus.

Merycomyia brunnea, n. sp.

Figs. 2a–c

Small for the genus; the entire body, pilosity, and wings uniformly brown.

Female: Length 12 mm, wing 11.5 mm. Eyes bare, when relaxed uniformly green. Frons twice as high as width across lower margin at inner angles of eyes, very slightly narrowed above. Ocelli prominent, yellow, each one narrowly ringed with blackish; frontal callus about two-thirds width of frons, slightly wider than high, with a short, acute dorsal projection that merges into a narrow groove reaching nearly to ocelli; the frontal callus very weakly shining, scarcely differentiated from the rest of the frons in this respect. Subcallus slightly protuberant, pollinose, without hairs. Antenna: Scape short, stout, triangular in profile, the angles rounded; pedicel short, stout, somewhat narrowed above; first flagellar segment oval in profile, slightly longer than broad; second slightly broader than long; third twice as long as broad, tapering; scape, pedicel, dorsum of first flagellar segment, and last two flagellar segments with hair. Palpus short and stout, the second segment about twice as long as broad, tapering to a blunt apex and with long hairs. Proboscis very short, the labella not exceeding palpi. Genae slightly swollen, with long brown hair. Thorax, abdomen, halteres, and legs entirely brown, with brown hair; thorax with very thin pollen; abdomen distinctly shining. Wing almost uniformly brown, the anal cell slightly paler, the stigma slightly darker; wing venation unmodified. Tibial spurs not as long as some of the adjacent hairs.

Holotype, female, U.S.N.M. no. 61676.

Type locality: New Smyrna Beach, Fla.

The single specimen was collected by C. M. Jones, July 20, 1951, from grass. Its small size and uniformly brown color readily separate it from the previously described species, as well as the one described above.

A KEY TO THE FEMALES OF THE GENUS MERYCOMYIA

1. Frons more than twice as high as width at lower margin; frontal callus a denuded area tapering above and extending nearly to ocellar tubercle 2
   Frons not more than twice as high as width at lower margin; frontal callus much shorter, scarcely higher than wide........ 3
2. Abdominal tergites 4 and 5 each with a pair of prominent white-pollinose patches *whitneyi* (Johnson)
   Abdominal tergites 4 and 5 without prominent white patches...............*mixta* Hine
3. Frons broad and distinctly narrowed above; larger species, the length 17 mm *haitiensis*, n. sp.
   Frons narrower, with nearly parallel sides; smaller species, the length 12 mm *brunnea*, n. sp.

Asaphomyia, n. gen.[1]

Small, rather stout, dark. Head very short. Ocelli on a very prominent tubercle in both sexes. Eyes nearly bare. No frontal callus in female. Antenna with scape and pedicel short; first flagellar segment short and stout, the second and third very slender and the third much longer than the second. Palpus stout, densely haired. Proboscis very short. Wing rather broad; vein R_4 with a stump, the venation otherwise unmodified. Hind tibial spurs small, but distinct.

Type of genus: *Asaphomyia texensis*, n. sp.

Asaphomyia texensis, n. sp.

Figs. 3a–c

Female: Length 8 mm, wing 7.5 mm. Almost uniformly dark brown, the head and thorax tinged with grayish, the abdomen darker, subshining. Frons about 1.5 times as high as width below, at vertex about three-fourths as wide as below. Ocelli very prominent on a nearly black, shining tubercle, bearing short dark hairs posteriorly; hairs on frons sparse, short. Eyes with a few short hairs, when relaxed uniformly green.

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[1] From *asaphos*, uncertain, baffling, obscure + *myia*, fly.

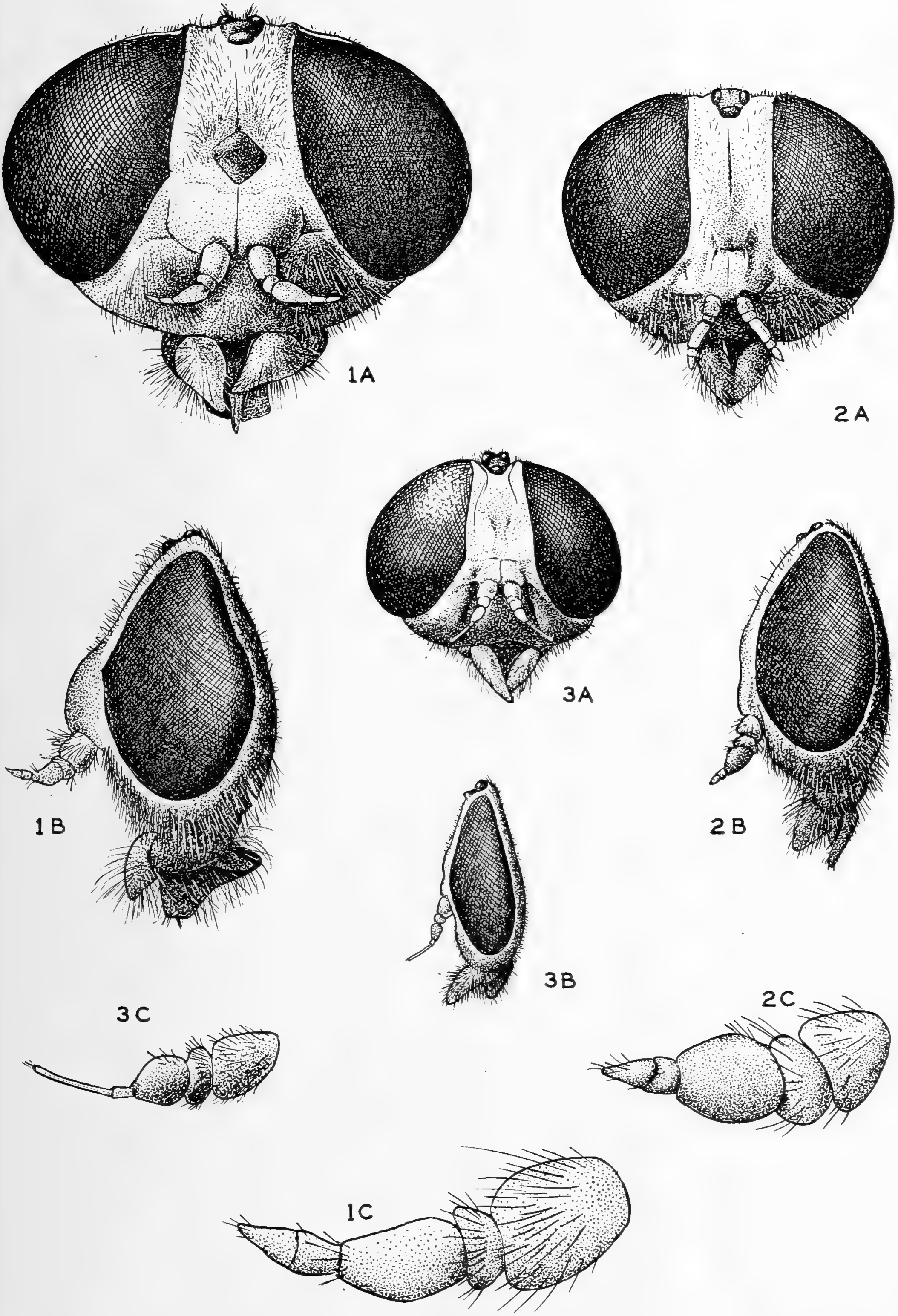


FIG. 1.—*Merycomyia haitiensis*, n. sp.: *a*, Front view of head; *b*, side view of head; *c*, antenna.
FIG. 2.—*Merycomyia brunnea*, n. sp.: *a*, Front view of head; *b*, side view of head; *c*, antenna.
FIG. 3.—*Asaphomyia texensis*, n. sp.: *a*, Front view of head; *b*, side view of head; *c*, antenna. (Drawings by Sally D. Kaicher.)

No frontal callus but a pair of curved grooves, deepest and narrowest above, weakly outline a central raised area; subcallus small, flat, with a median groove and without hairs. Antenna: Scape and pedicel small, dark brown, with short dark hairs; first flagellar segment small, nearly round in profile, the extreme base slightly paled; second and third flagellar segments straw yellow, the second segment very short, the third long, narrowest at base, with a few pale hairs at tip. Clypeus and genae dark brown, with black hair. Palpus short, stout; second segment distinctly longer than first, curved and tapering distally. Proboscis very short, the palpi extending well beyond the labellae. Thorax brown, the dorsum tinged with gray, but with no stripes. Halteres brown. Wings brown, somewhat darker along anterior margin; vein R_4 with stump parallel to vein R_{4+5}. Legs dark brown with concolorous hair; hind tibial spurs short but distinct. Abdomen stout, dark brown, subshining.

Male: As in female except: Length 9 mm; head large, holoptic, the facets above level of antennae distinctly enlarged; ocelli on an even more prominent tubercle. Abdomen somewhat tapering posteriorly. Hind tibial spurs slightly longer.

Holotype, female, paratype male: U. S. Nat. Mus. no. 61677; paratypes, 2 females, 2 males, American Museum of Natural History.

Type locality: Columbus, Tex.

The type bears no further data. The male in the U. S. National Museum was collected at Victoria, Tex., on May 3, 1913, by Mitchell and Coad. The two pairs in the American Museum of Natural History, lent me by C. H. Curran, were collected at Weser, Goliad County, Tex., May 11, 1952, by Cazier, Gertsch, and Schrammel. The generic name was suggested to M. D. Leonard in 1921 by E. A. Schwartz. At that time the family position of the species was very uncertain, but it is quite evidently closely related to *Merycomyia* in spite of its small size and unusual antennae.

ZOOLOGY.—*A new genus of bonelliid worms* (*Echiuroidea*). WALTER K. FISHER. Associate in Zoology, Smithsonian Institution. (Communicated by Fenner A. Chace, Jr.)

The new genus and species described herein belongs in the phylum Echiuroidea, order Echiuroina, family Bonelliidae, and was taken from the depths of the central lagoon of Onotoa, Gilbert Islands, by Dr. P. E. Cloud, Jr., on August 25, 1951.

Achaetobonellia, n. g.

Diagnosis.—Differing from typical *Bonellia* in the absence of setae; in the presence of a thick-walled bulbous expansion of the neck of the nephridium between the subbasal nephrostome and body wall, functioning as a specialized androecium; in having an extraordinarily long segment of the gut between the mouth and point of attachment of the neurointestinal blood vessel to gut; siphon apparently rudimentary; anal vesicles numerous. Type, *Achaetobonellia maculata,* n. sp.

Achaetobonellia maculata, n. sp.

Description.—Body form a broad ellipsoid, 45 mm long; body wall thin, translucent; skin smooth with slight rugosities at ends of body; skin marked by small dark brown spots, most numerous on proboscis. The latter is 95 mm long and about 6 mm broad when flattened; each terminal branch is about 20 mm long. The mouth is inconspicuous, in the base of proboscis the margins of which do not fuse to form a definite lower lip. The nephridiopore is very inconspicuous.

The alimentary canal is very long, about 400 mm, the first 150 mm being the segment between mouth and attachment of neurointestinal blood vessel (B^3). Pharynx subspherical, thin-walled, distended by white coral mud. A rather short esophagus follows, beyond the end of which the entire gut is filled with chalk-white pellets. There is no clear differentiation into gizzard and stomach. At certain places on the badly preserved intestine traces of what may be a rudimentary siphon can be seen, but there is not observable a definite beginning at or near the attachment of the neurointestinal vessel as is normal in bonelliids. A portion of the intestine just anterior to the small, very thin-walled cloaca is enlarged but there is no trace of a ciliated groove such as is obvious in the "hind gut" of *Nellobia eusoma* (Fisher, 1946, pl. 29, fig. 3).

The anal vesicles are rather numerous

arborescent structures on the walls of the cloaca rather than 2 definite elongate sacs with branches. They are not so voluminous as in *Nellobia eusoma.* The elements are similar to those of *Eubonellia valida* (Fisher, 1946, pl. 28, fig. 2), but the ciliated funnels have disappeared. The gonads could not be found.

The single, left, nephridium, about 25 mm long, has a subbasal nephrostome on a short stalk directed toward the nerve cord. Its distinctive feature is a thick-walled proximal chamber between the nephrostome and body wall, functioning as an androecium. One male was found with its posterior end immersed in the soft glandular lining, to which it may be permanently attached. Distal to the nephrostome the walls are translucent and small eggs occupied the middle portion.

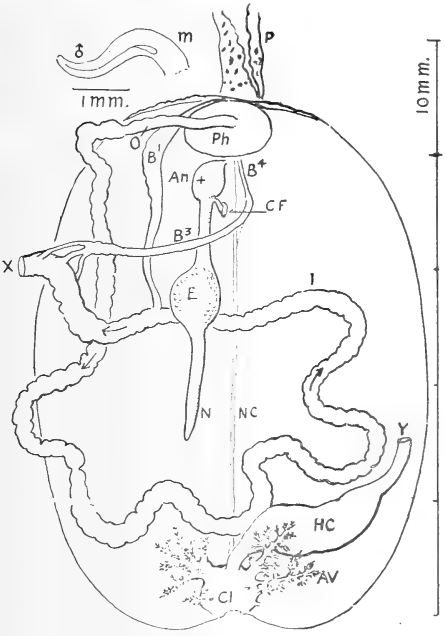


FIG. 1.—*Achaetobonellia maculata,* ×1.5: Map of the anatomy from above, to show especially the single nephridium or "uterus" and the very long segment of gut anterior to attachment of dorsal blood vessel, B^1. Between X and Y 300–350 mm of intestine have been removed. (An, androecium; AV, anal vesicles; B^1, B^3, B^4, dorsal, neurointestinal, ventral blood vessels respectively; CF, nephrostome; Cl, cloaca, E, eggs in nephridium; HG, enlarged terminal part of intestine; I, presiphonal segment of gut; m, anterior part of a male taken from androecium; N, nephridium; NC, nerve cord; O, esophagus; P, proboscis; Ph, pharynx; +, position of male in the andoecium.)

The male is without hooks, and is slenderer than that of *Bonellia viridis.* The posterior part is missing; possibly it remained attached to the tissue of the androecium. The spermatheca is relatively small. Its duct opens at or close to the anterior end.

Type.—U.S.N.M. no. 24618.

Type locality.—Onotoa, Gilbert Islands, in deep central part of lagoon. P. E. Cloud, collector, August 25, 1951.

Remarks.—It is regrettable to have to add another monotypic genus to the Bonelliidae, but until we learn the value of the characters available for taxonomic purposes analysis will have to precede synthesis. In my review of the Bonelliidae (1948) I gave a synopsis of the 16 genera into none of which the present species fits, although it seems to be nearest *Nellobia.* If *Nellobia eusoma* has a typical Bonelliid proboscis it may be possible to squeeze *Achaetobonellia maculata* into that genus but there will remain the big discrepancy in structure of the gut, for *Nellobia* has a normal siphon, does not have the same nephridial structure, nor the excessively long "foregut". It has about the thickest body wall of any known Bonelliid.

The new genus will fall into section a^1, b^2 of my synopsis, as follows:

c^1. Two nephridia; no setae—*Hamingia* Koren and Danielssen
c^2. One nephridium.
  d^1. Two typical setae; no specialized androecium. *Bonellia* Rolando
  d^2. Setae numerous, seated in two muscular pads from which muscles radiate; no androecium. *Acanthobonellia* Fisher
  d^3. No setae; a specialized androecium at base of nephridium. Differing also from d^1 and d^2 in having an abnormally long foregut and rudimentary siphon, and more diffuse anal vesicles. *Achaetobonellia,* n.g.

LITERATURE CITED

FISHER, W. K. *Echiuroid worms of the North Pacific Ocean.* Proc. U. S. Nat. Mus. **96:** 215–292, pls. 20–37. 1946.

———. *A review of the Bonelliidae (Echiuroidea).* Ann. Mag. Nat. Hist. (11) **14:** 852–860. Dec. 1947 (= Aug. 1948).

MALACOLOGY.—*The gross anatomy and occurrence in Puerto Rico of the pelecypod* Yoldia perprotracta.

GERMAINE L. WARMKE, Mayagüez, Puerto Rico, and R. T. ABBOTT, U. S. National Museum. (Communicated by Harald A. Rehder.)

Yoldia (*Adrana*) *perprotracta* Dall, hitherto believed to be extinct, was first collected by D. F. MacDonald near Mount Hope, Canal Zone, and described by Dall (1912, p. 1) as a new species from the Pleistocene. This species was also reported as a Pleistocene fossil from the oyster shell layers of the Black Swamp near Mount Hope by Brown and Pilsbry (1913, p. 496).

Live specimens of *Yoldia perprotracta* were collected by the senior author on August 15, 1951 while dredging between the city of Mayagüez and the mouth of the Añasco River, Puerto Rico. Many specimens came up in from 10 to 25 feet of water from a muddy bottom. Since then, scores of live specimens have been dredged from three other localities on the west coast of the island (Punta Arenas; Boquerón; and off Piñero Island).

Our Recent specimens closely match those from the type lot (holotype: U.S.N.M. no. 214350; paratypes: 605551). The type was figured by Dall (1925, pl. 18, fig. 3) and described (Dall, 1912, p. 1) as thin, elongated, inequilateral, rather bluntly pointed at the posterior, and more rounded at the anterior end; beaks depressed and inconspicuous. Exterior polished, showing regular concentric striae with wider interspaces; hinge with about 38 anterior and 48 posterior teeth separated by a small, subtriangular pit. Length 29 mm., height at the beaks 8, maximum diameter 5 mm. In Recent specimens, the number of posteiorr teeth ranges in number from 45 to 51, anterior teeth from 31 to 34. Fossil paratypes have from 44 to 51 posteriors, 35 to 38 anteriors (5 specimens).

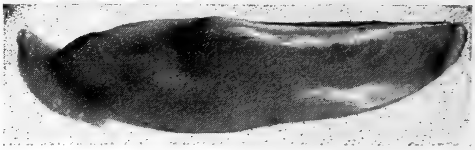


FIG. 2.—*Yoldia* (*Adrana*) *perprotracta* Dall (1 inch), Mayagüez, Puerto Rico.

The general gross anatomy of *Yoldia perprotracta* is very similar to that described for *Yoldia limatula* Say (Drew, 1899a and 1899b). Our preserved specimens did not show the presence of a siphonal tentacle. The postero-ventral margins of the mantle bear a series of from 30 to 37 small, swollen papillae, each of which bears three tiny, fleshy protuberances. The papillae and protuberances are largest at the posterior end. The palp-appendages (used as food gatherers) appear to be proportionately larger than those found in *Y. limatula.* The gills are typical for the genus and contain about 90 closely packed lamellae.

LITERATURE CITED

BROWN, A. P., and PILSBRY, H. A. *Two collections of Pleistocene fossils from the Isthmus of Panama.* Proc. Acad. Nat. Sci. Philadelphia 1913: 493–500.

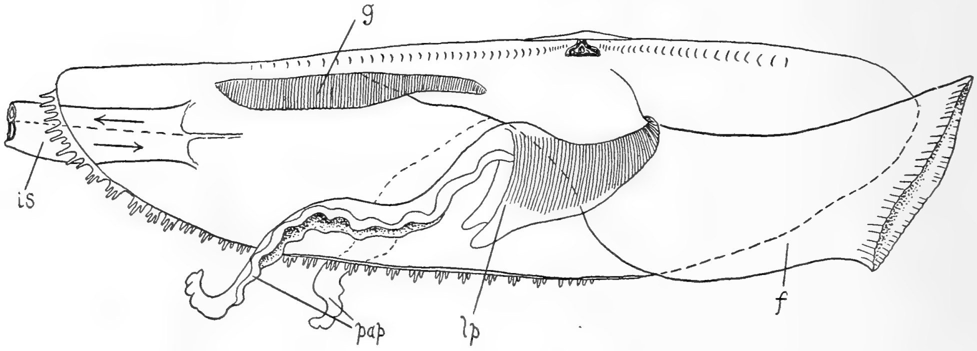


FIG. 1.—Main anatomical features of *Yoldia* (*Adrana*) *perprotracta* Dall: f, Foot; g, gills; is, inhalant siphon; lp, right labial palp; pap, palp-appendages.

Dall, W. H. *New species of fossil shells from Panama and Costa Rica.* Smithsonian Misc. Coll. **59**(2): 1–10. 1912.

———. *Illustrations of unfigured types of shells in the collection of the United States National Museum.* Proc. U. S. Nat. Mus. **66**(2554): 1–41. pls. 1–36. 1925.

Drew, G. A. Yoldia limatula. Mem. Biol. Lab. Johns Hopkins Univ. **4**(3): 1–37, pls. 1–5, 1899a.

———. *Some observations on the habits, anatomy and embryology of members of the Protobranchia.* Anat. Anz. **15**(24): 493–519. 1899b.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

55th ANNUAL MEETING

The 55th Annual Meeting, concurrently with the 360th monthly meeting of the Academy, was held as a dinner meeting in the ballroom of Hotel 2400 on the evening of January 15, 1953. President Walter Ramberg presided.

After the dinner President Ramberg called the meeting to order at 8:15 p.m. No changes were suggested for the minutes of the 54th Annual Meeting as published in the Journal **42**(6): 198–204, June 1952.

Excerpts from the following reports by officers and committee chairmen were presented:

REPORT OF THE SECRETARY

During the Academy year—January 17, 1952, to January 15, 1953—62 persons were elected to regular membership, including 59 resident and 3 nonresident (62 were elected last year). Of these, 52 resident and 3 nonresident have as of this date qualified for membership. Three resident members elected in the preceding Academy year qualified during the year just ended. Two elected to membership on January 12, 1953, have not yet been notified of their election. The new members were distributed among the various sciences as follows: Physics 11; chemistry 9; entomology 5; 4 each in zoology and anthropology; biology 3; 2 each in astronomy, astrophysics, bacteriology, biochemistry, geology, mathematics, medicine, physiology, and psychology; and 1 each in aeronautics, archeology, anatomy, botany, histology, philosophy, pathology, and mycology. Eight members, having held membership for over 10 years and having retired from the gainful practice of their professions, were placed on the retired list entitled to privileges of active membership without further payment of dues. Nine resident and 2 nonresident members resigned in good standing. No members were dropped for nonpayment of dues, as the list has not been reviewed by the Board.

Deaths in 1952 of 21 members were reported to the Secretary, as follows:

Malcolm M. Haring, on January 1
T. Wayland Vaughn, on January 16
Walter T. Swingle, on January 19
William S. Eichelberger, on February 3
Charles E. Chambliss, on February 10
Joseph S. Caldwell, on February 18
George W. McCoy, on April 2
James L. Peters, on April 19
Raymond A. Kelser, on July 15
Eugene C. Auchter, on August 12
Ida A. Bengtson, on August 15
Paul F. Nemenyi, on August 29
Albert E. McPherson, on September 6
Edward F. Wendt, on September 30
Harold E. McComb, on October 11
Paul A. Neal, on October 13
Harvey N. Davis, on December 3
Charles L. G. Anderson, on December 10
Miriam L. Bomhard, on December 16
Arthur B. Lamb, on December 18
M. C. Merrill, on December 22

On January 15, 1953, the status of membership was as follows:

	Regular	Retired	Honorary	Patron	Totals
Resident	626	55	0	0	681
Nonresident	186	36	10	0	232
Total	812	91	10	0	913

The net changes in membership during the past year are as follows:

	Regular	Retired	Honorary	Patron	Totals
Resident	+37	+1	0	0	+38
Nonresident	+4	−3	0	0	+1

During the Academy year 1952 the Board of Managers held 8 meetings, with an average attendance of 17. The following summarizes incidental items, not covered elsewhere in this annual report, pertaining to activities of the Academy and its Board of Managers.

A Committee on Science Education was appointed to cooperate on behalf of the Academy with the D. C. Council of Engineering and Architectural Societies in an effort to achieve in the high schools in the metropolitan area adequate courses and interest among qualified students in mathematics and science. This committee consists of Wallace R. Brode, Chairman, W. T. Read, and N. L. Drake.

A special committee for Considering the Establishment of a Junior Academy of Sciences was appointed consisting of Martin A. Mason, Chairman, A. T. McPherson, and E. H. Walker. Subsequently by vote of the members of the Academy sponsorship was approved, and the Bylaws of the Washington Academy were amended to provide that a member shall be appointed annually by the President to serve as Chairman of the Governing Board of the Washington Junior Academy of Sciences.

The Academy has continued its support of publication of the weekly Science Calendar in local newspapers.

In April the District of Columbia Section of the Society for Experimental Biology and Medicine by vote of the Academy members became the 20th Affiliated Society of the Academy. N. R. Ellis was named Vice-President of the Academy representing the D. C. Section.

Grants-in-Aid for Research totaling $400 were made to Freeman A. Weiss and to Edward Hacskaylo. This allocation is from funds received by the Academy from the American Association for the Advancement of Science on the basis of the number of Academy members who also belong to the AAAS.

The Board approved publication of the Red Book in an abbreviated form. It will contain material descriptive of the Academy and its objectives, together with the Bylaws and Standing Rules of the Board of Managers. A page each will be devoted to the Affiliated Societies. This will contain a brief statement on the history, purpose, and operations of the Society and a list of current officers. Other members of the Affiliated Societies will not be listed unless they are also members of the Academy.

During the Academy year, 7 meetings of the Academy were held, as follows:

On February 21, 1952, L. I. Barrett, chief of the Division of Forest Management Research, U. S. Forest Service, delivered a lecture on *The status and development of the Federal program of forest genetics research.*

On March 20, 1952, the 1951 Academy Awards were presented to Edward William Baker, Bureau of Entomology and Plant Quarantine, for work in the biological sciences; Max A. Kohler, Weather Bureau, for work in the engineering sciences; Milton Seymour Schechter, Bureau of Entomology and Plant Quarantine, for work in the physical sciences; and Howard B. Owens, a special award for the teaching of science.

On April 17, 1952, William L. Whitson, deputy director, Operations Research Office, Johns Hopkins University, delivered a lecture entitled *Can scientists diagnose the most important maladies of the nation?*

On May 15, 1952, M. H. Trytten, director, Office of Scientific Personnel, National Research Council, spoke on *Significant aspects of scientific personnel problems.*

On October 16, 1952, the Academy held a joint meeting with the Entomological Society of Washington at which Carroll M. Williams delivered an illustrated lecture on *The morphogenesis and metamorphosis of insects.*

On November 20, 1952, John P. Hagen, of the Naval Research Laboratory, delivered a lecture on *Radio astronomy.*

On December 18, 1952, Henry Randall, of the Research and Development Board, spoke on *The Activities and responsibilities of the Research and Development Board.*

The Annual Dinner meeting was held at Hotel 2400 on January 15, 1953. J. W. Joyce, deputy science adviser, Department of State, spoke on *Science in the State Department.* (Published in this Journal **43**(4): 97–103, April 1953.)

F. M. Defandorf.

REPORT OF THE TREASURER

The Treasurer submitted the following report concerning the finances of the Washington Academy of Sciences for the year ended Deember 31, 1952.

RECEIPTS

Dues, 1948	$ 6.00	
1949	11.00	
1950	57.00	
1951	167.00	
1952	4,153.25	
1953	133.00	
1954	6.00	$4,533.25
Journal,		
Subscriptions, 1950	15.00	
1951	150.00	
1952	717.41	
1953	819.91	
1954	18.56	1,720.88

Reprints, 1949	29.28	
1950	7.44	
1951	556.86	
1952	547.24	1,140.82
Sales, 1952		
Miscellaneous; Journals, Proceedings and Directories	169.47	
Journals in sets	1,002.25	1,171.72
Monograph No. 1		137.90
Interest and Dividends, 1951	167.00	
1952	2,360.84	2,527.84
Annual Dinner (Jan. 1952)		346.50
Meetings Committee		31.50
Overpayments		1.00
Grants-in-Aid from A.A.A.S.	400.00	
Grants-in-Aid returned	170.00	570.00
Contributions for Science Calendar		5.70
Contributions for Science Fair		480.00
Junior Academy		104.00
Total receipts, 1952		$12,771.11
Cash book balance as of Jan. 1, 1952		4,078.07
		$16,849.18

DISBURSEMENTS

	1951	*1952*	*Total*
Secretary's Office	$ 73.52	$ 481.87	$ 555.39
Treasurer's Office	164.38	85.46	249.84
Subscription Manager and Custodian of Publications		25.70	25.70
Archivist		9.00	9.00
Meetings Committee	108.49	343.27	451.76
Membership Committee		9.72	9.72
Journal			
Printing and mailing	555.00	5,020.92	5,575.92
Illustrations	38.47	459.07	497.54
Reprints	164.45	637.33	801.78
Office			
Ed. Asst.	25.00	425.00	450.00
Misc.	1.53	44.51	46.04
Monograph No. 1		5.96	5.96
Refund, overpayment		1.00	1.00
Refund, subscription		6.75	6.75
Bad check		30.00	30.00
Annual dinner		395.70	395.70
Grants-in-aid		630.00	630.00
Science Calendar		89.09	89.09
Science Fair		189.20	189.20
Junior Academy		55.58	55.58
Charges against sales, 1952		2.50	2.50
Academy Conference A.A.A.S.		5.00	5.00
Total	$1,130.84	$8,952.63	$10,083.47
Cash book balance as of December 31, 1952			6,765.71
Total accounted for			$16,849.18

RECONCILIATION OF BANK BALANCE

		1952	*Total*
Cash book balance, December 31, 1952			$6,765.71
Balance as per Amer. Sec. & Trust Co. Statement of Dec. 16, 1952		$5,150.29	
Receipts undeposited		1,810.36	
		$6,960.65	
Checks outstanding as of December 31, 1952			
No. 1018	$ 5.41		
1263	5.00		
1596	6.75		
1598	63.00		
1599	1.75		
1600	2.01		
1601	36.75		
1602	55.04		
1603	19.23	194.94	$6,765.71

INVESTMENTS

Potomac Electric Power Co.		
Certificate No. TAO 1977—40 shares 3.6% pref. at $43.50		$1,740.00
City of New York		
3% (Transit Unification) Due June 1, 1980		
Certificate No.		
D 20186	$ 500.00	
C 71038	100.00	
C 71039	100.00	
C 71040	100.00	800.00
Northwestern Federal Savings & Loan Association		
Certificate No.		
1380	$4,500.00	
1441	500.00	$ 5,000.00

United States Government		
Series G Bonds:		
No. M332990G	$1,000.00	
M332991G	1,000.00	
M332992G	1,000.00	
M332993G	1,000.00	
M1808741G	1,000.00	
M2226088G	1,000.00	
M2982748G	1,000.00	
M4126041G	1,000.00	
M5141346G	1,000.00	
M5141347G	1,000.00	$10,000.00
Massachusetts Investors Trust		
835 shares @ $20.42		$17,050.70
Investment Company of America		
400 shares @ $12.33		4,932.00
State Street Investment Corporation		
100 shares @ $68.50		6,850.00
American Security & Trust Co.		
Savings account		161.52
Total		$46,534.22
Cash book balance as of December 31, 1952		6,765.71
Total		$53,299.93
Total as of December 31, 1951	$48,301.19	
Total as of December 31, 1952	53,299.93	
Increase	$ 4,998.74	

At the close of business December 31, 1952, there were a total of 69 members who were delinquent in dues—an increase of 11 over the number reported a year ago.

HOWARD S. RAPPLEYE.

REPORT OF AUDITING COMMITTEE

The accounts of the Treasurer of the Washington Academy of Sciences for the year 1952 were examined by the auditing committee on January 7, 1953.

The Treasurer's report attached was found to be in agreement with the records. All disbursements had been authorized and were found to be supported by vouchers and canceled checks. The securities of the Academy were inspected and found to be in agreement with the list given in the report and to have all coupons attached that are not yet due.

The committee is unanimous in its commendation of the Treasurer, Mr. Rappleye, for the efficient and orderly way in which the records are kept.

C. L. GAZIN, *Chairman.*

REPORT OF THE ARCHIVIST

The highlight of the year was the discovery of the minutes of the proceedings of the Joint Commission of Scientific Societies of Washington from its organization on February 25, 1888, until it adjourned *sine die* with the formation of the Academy on March 22, 1898. Included also was a set of directories of the members of the scientific societies of Washington 1889 to 1898. These records in three volumes were found by J. G. Thompson, chief of the Metallurgy Division, National Bureau of Standards, in the course of a clean-up operation at the Bureau and were turned over to President Ramberg for the Academy's files. The minutes provide a valuable historical background to the history of the Academy and a very human document on the workings of politics in local scientific circles for the period involved. The Joint Commission was set up by formal action of the Washington scientific societies of 1888, the Chemical Society, the National Geographic Society, the Anthropological Society, the Philosophical Society, and the Biological Society to care for matters of "common interest." At a later date the Geological and Entomological Societies were admitted to the sacred circle, although not without considerable maneuvering.

The Commission during its existence sponsored the 1891 meeting of the American Association for the Advancement of Science in Washington, collecting for the purpose about $2,700 of which $1,600 was expended for program printing, a free trip to Mount Vernon for the visitors and other expenses. The balance after lengthy discussion was left in the Treasury to finance the Commission's other activities. Annual directories of the membership of the affiliated societies were published as forerunners of the Academy Red Book series. A series of Saturday afternoon scientific lectures were sponsored and for a brief time the Commission managed the meetings at which addresses of retiring presidents of the several societies were presented.

These records have been added to the Archives of the Academy.

JOHN A. STEVENSON.

REPORT OF THE BOARD OF EDITORS

Volume 42 of the JOURNAL brought out during 1952 includes 396 numbered pages, 8 less than volume 41 for 1951. Published papers include 46 in zoology and its branches; 22 in geology, paleontology, and mineralogy; 8 in botany; 3 in anthropology and ethnology; 2 in biochemistry; and 1 each in physics and meteorology. Distribution of subjects did not differ greatly from that of the previous volume. Also published were 10 obituaries; the proceedings of the Academy for 1951 and 1952 and of two affiliated societies; and a list of newly elected members.

The disbursements for the Journal during 1952 were:

Printing, engraving, wrapping, mailing, etc.	$6,473.44
Reprints	824.60
Office—editorial assistance	465.00
Office—postage	31.28
Total	$7,794.32
Charge to authors	1,154.73
Net cost of volume 42 to the Academy	$6,639.59

William F. Foshag, *Senior Editor*

REPORT OF CUSTODIAN AND SUBSCRIPTION MANAGER OF PUBLICATIONS

Subscriptions

Nonmember subscriptions in the continental United States	149
Nonmember subscriptions in U. S. possessions and foreign lands	75
Total	224

Inventory of stock as of December 31, 1952

Reserve sets of the Journal

Complete sets, vols. 1–42	1 set
Volumes 11–42	6 sets
16–42	9 sets
21–42	7 sets
Total sets more or less complete	23 sets

Back numbers of the Journal

Numbers held in complete sets	687
Numbers held in reserve for complete sets	8,839
Numbers held for individual sale	—*
Total numbers on hand	*

* A complete count has not been made.

Proceedings

Complete sets (volumes 1–13)	47 sets

(the individual volumes outside of the complete sets, and the copies of the separate articles that appeared in the Proceedings have never been counted.)

Monograph No. 1

Original issue		1,010
Copies sold or distributed in previous years	173	
Copies sold in 1952	30	
Total sold or distributed		203
Number of copies on hand		807

Sales

During the year 1952 one complete set of the Journal and of the Proceedings was sold to the Humble Oil & Refining Co., of Houston, Tex. Of the numbers of the Journal 186 were sold, either individually or as volumes.

Seventy-five numbers of the Proceedings were sold this year, the largest number in many years.

The sales of the Monograph showed a continuing decline, although the decrease from sales in the previous year was small. Thirty copies were sold in 1952, as against 32 in 1951. I feel that in order to sell more of these books the price will have to be reduced considerably.

This year again many members and institutional libraries very generously turned over to the Custodian unwanted back numbers of the Journal. For these donations the Academy is very grateful.

The income from sales of individual numbers and volumes of the Journal and Proceedings was $169.47, and from sales of the Monograph was $137.90. Payment was received for three complete sets of the Journal and one set of the Proceedings, two of these having been sold in 1951 and one last year; this amounted to $1,002.25. The total income from sales was $1,309.62.

Expenditures

Supplies	$ 4.24
Purchase of directories (Red Book)	6.75
Expenses in connection with Journal, etc.	10.21
Expenses in connection with Monograph	2.29
Total	$23.49

Storage

Further progress was made in the rearrangement of the storage facilities that we have in the Smithsonian Institution Building. I hope that this present year will see the completion of this project, so that a complete count and rearrangement of the stock of the Journal and the Proceedings can be made.

Harald A. Rehder.

REPORT OF COMMITTEE ON MEMBERSHIP

The membership committee during the past year has received, examined, questioned, and finally accepted and recommended to the Board of Managers for membership in the Academy 61 nominees. All have had such high qualifications that none were turned down by the committee or the board. Hence, the committee may be accused of lowering the Academy's traditional high standards. However, we are willing to let the records speak in our defense.

I wish to take this opportunity to advance our work and the welfare of the Academy by bringing to your attention the way this committee operates and what is needed to make it better serve its ends.

The function of the committee is: (1) To receive and evaluate nominations and to recommend approved names to the board; (2) to prepare nominations for other eligible scientists; and (3) to encourage and aid Academy members at large to prepare nominations.

There are 16 members of the committee representing about that same number of organizations which contain members and potential members in this community. But there are in our midst more than 16 organizations with scientists on their staffs. Hence, during the past year we have broadened our contacts by soliciting the active participation of 38 additional Academy members in the same number of additional organizations. Many of the 61 nominations received during the past year have been submitted by these special representatives. Others have been submitted by members not connected with this committee and the rest by committee members. I am sure that we as well as these new members are all grateful to these sponsors for taking the trouble to bring into the Academy so many highly qualified people.

But the committee is not satisfied as long as there are vacancies in the Academy and there are qualified scientists who have not been invited to accept membership. And both of these conditions currently exist.

In spite of our 16 committee members and 38 other representatives there are overlooked offices and scientists with no one to nominate them. Some of our special workers have been too busy and procrastination exists in all of us. Therefore we need active participation by all Academy members. It is the privilege and responsibility of each member who values his membership in this organization to see that no qualified associate of his is overlooked. I consider it an honor to belong to this organization and believe my qualified associates will appreciate the same privilege. It is my responsibility to see that they are nominated.

Let me outline briefly the procedure in case it is unknown to some of you. First, any member of the membership committee or the secretary can supply you with nomination forms. The names of all committees are published in each issue of the Journal of the Washington Academy of Sciences. Secondly, the form should be filled out in full. This is sometimes not a simple task, especially since it is generally considered advisable not to seek directly the participation of the nominee. Thirdly, the signatures of three Academy members are needed for sponsors on each nomination. The nomination when completed may be turned over to any member of the membership committee or to the secretary of the Academy.

The committee then reviews the nominee's qualifications and presents acceptable names to the Board at its next meeting. At the Board's following monthly meeting names are voted on, after which the secretary sends an invitation to the nominee to accept membership. We have just instituted the practice of notifying at the same time the chief sponsor that his nominee has been accepted.

EGBERT H. WALKER, *Chairman*

REPORT OF COMMITTEE ON AWARDS FOR SCIENTIFIC ACHIEVEMENT

The recommendations of the Committee on Awards for Scientific Achievement for 1952 were presented to the Board of Managers of the Washington Academy of Sciences at its regular December meeting. The recommendations were unanimously approved, and awards were granted as follows:

For the Biological Sciences, to ERNEST A. LACHNER, of the United States National Museum, in recognition of his distinguished service in ichthyology, especially in the taxonomy of apogonid and mullid fishes.

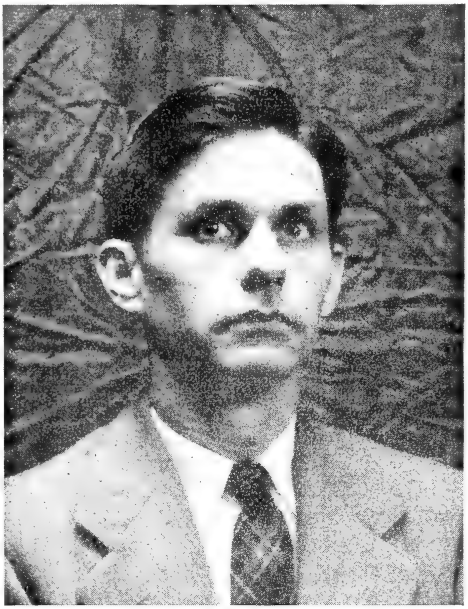
For the Engineering Sciences, to WILLIAM R. CAMPBELL, of the National Bureau of Standards, in recognition of his distinguished research in the strength of materials of structures.

For the Physical Sciences, to HAROLD LYONS, of the National Bureau of Standards, in recognition of his achievement in using the absorption

Ernest A. Lachner, United States National Museum, for the *Biological Sciences*

William R. Campbell, National Bureau of Standards, for the *Engineering Sciences*

Harold Lyons, National Bureau of Standards, for the *Physical Sciences*



Keith C. Johnson, District of Columbia Public Schools, for the *Teaching of Science*

Washington Academy Award Winners, 1952

of microwaves in developing the first atomic clock.

A special award for the Teaching of Science was granted to KEITH CHARLES JOHNSON, Department of Science, District of Columbia Public Schools, for his achievements in attracting and encouraging the interest of our youth in science and providing through the Science Fair the recognition and encouragement so necessary to continued activity in science by youth.

JASON R. SWALLEN, *General Chairman*

REPORT OF COMMITTEE ON ENCOURAGEMENT OF SCIENCE TALENT

The organization of the Washington Junior Academy of Sciences on June 13, 1952, was the culmination of plans that had been in process of development for about six years. The present membership of the Junior Academy consists of 65 regular members who are pupils in the local secondary schools, 19 alumni members, and 29 fellows who are either teachers or scientists particularly interested in young people. Election to membership is based on demonstrated accomplishment in science, just as membership in the Academy proper. With pupils this accomplishment consists in winning an award or substantial recognition in a science talent search or the science fair; teachers are elected on the basis of the accomplishments of their pupils. The Junior Academy is governed by a council made up of its officers together with other elected representatives and the Committee on the Encouragement of Science Talent. Funds are handled by the treasurer of the Academy.

An important function of the Junior Academy consists in bringing students into touch with professional scientists in fields of their interest. The George Washington University was host at a conference on September 19 at which, after a general program, ten teams of well-known scientists met with the Junior Academy members in small groups to aid in the selection and planning of projects to be worked on during the current year.

As a further means of stimulating interest in science in the schools, the Committee on the Encouragement of Science Talent has joined with a similar committee of the D. C. Council of Engineering and Architectural Societies in assigning the local Junior and Senior High Schools to teams of scientists and engineers for the purpose of arranging assembly programs and conferences with science clubs and other small groups of interested students.

The Philosophical Society of Washington instituted this year an annual Christmas Lecture for Young People patterned after the Christmas Lectures of the Royal Society. The first lecture was given on December 30 by Dr. E. H. Land, of the Polaroid Corporation, on *The rôle of science in the technique of invention—a demonstration lecture in the fields of two-dimensional and three-dimensional photography.* The Junior Academy gave the lecture publicity in the schools and provided much of the audience.

The Committee on the Encouragement of Science Talent conducted, as in previous years, a District of Columbia Science Talent Search among students who had entered the national competition conducted by Science Service for the Westinghouse Educational Foundation. Six students were found to have done work of outstanding originality and were recommended for Certificates of Merit which were awarded by the Academy. In the future this local science talent search will include all schools in Maryland and Virginia within a radius of 25 miles, which is the territory of the Washington Academy.

While the Science Talent Search is an activity restricted to pupils graduating from Senior High School, the local Science Fair is open to all pupils of both Junior and Senior High Schools, and hence reaches a much larger number. The Sixth Annual Washington D. C. Science Fair was sponsored by the Science Clubs of America, the Washington Academy of Sciences, and its affiliated societies, and was held at the Gymnasium of the Catholic University on April 23–27, 1952. Many members of the Academy participated as judges. The expenses of the Fair, amounting to $906, were met by a benefit performance of the documentary motion picture, Kon-Tiki, and by gifts.

Plans are well under way for the Seventh Annual Science Fair to be held April 30 to May 3, 1953, in the two gymnasiums of the American University.

A. T. MCPHERSON, *Chairman*

The President on behalf of the Academy spoke appreciatively of the work during the year (1) of the Meetings Committee, HARRY W. WELLS, Chairman; (2) of the Committee on Grants-in-Aid, L. E. YOCUM, Chairman; (3) of the Policy and Planning Committee, W. A. DAYTON, Chairman; (4) of the Committee on Monographs, W. N. FENTON, Chairman; and (5) of the Special

Committee on Science Education, W. R. Brode, Chairman.

After a report of G. P. Walton, Chairman of the Committee of Tellers, the President declared the following elected:

Francis M. Defandorf, *President-Elect*
Jason R. Swallen, *Secretary*
Howard S. Rappleye, *Treasurer*
Martin A. Mason and Raymond J. Seeger, *Elected Members Board of Managers to January 1956.*

The following members of the Academy, nominated by the Affiliated Societies, were duly elected Vice-Presidents of the Academy:

Anthropological Society of Washington—William H. Gilbert
Biological Society of Washington—Hugh Thomas O'Neill
Chemical Society of Washington—George W. Irving, Jr.
Entomological Society of Washington—F. W. Poos
National Geographic Society—Alexander Wetmore
Geological Society of Washington—A. Nelson Sayre
Columbia Historical Society—Gilbert H. Grosvenor
Botanical Society of Washington—Harry A. Borthwick
Washington Section, Society of American Foresters—George F. Gravatt
Washington Society of Engineers—C. A. Betts
Washington Section, American Institute of Electrical Engineers—Arnold H. Scott
Washington Section, The American Society of Mechanical Engineers—Richard S. Dill
Washington Branch, Society of American Bacteriologists—Glenn Slocum
Washington Post, The Society of American Military Engineers—Floyd W. Hough
Washington Section, Institute of Radio Engineers—Herbert Grove Dorsey
District of Columbia Section, American Society of Civil Engineers—Martin A. Mason
District of Columbia Section, Society for Experimental Biology and Medicine—N. R. Ellis

As a consequence of this annual meeting taking place earlier than executive committee meetings of the following Affiliated Societies, their nominations for Vice-Presidents were not yet available and will therefore await action at a later meeting of the Board of Managers: Philosophical Society of Washington, Medical Society of the District of Columbia, Helminthological Society of Washington.

President Ramberg introduced J. W. Joyce, deputy science adviser of the Department of State and also a member of the Academy, as the speaker of the evening. Mr. Joyce outlined developments that led to the establishment of the Office of the Science Adviser to the Department of State. He cited the need for better and prompt interchange of scientific information on new developments in various fields and explained how this need was being met by having individuals with scientific backgrounds as attaches in foreign offices. Missions have been established in London, Paris, Rome, and Stockholm with the necessary provisions for travel and liaison work. Thus it is now possible through this facility for travelling scientists from this country to obtain help in establishing prompt connections with others active in similar fields. Several members mentioned the desirability of publishing the material presented in the Journal.

President Ramburg thanked the Academy members for their willing cooperation in the work of the Academy during the year and then introduced the new President, Frank M. Setzler, who had served as President-Elect during 1952. After appropriate remarks the new President suggested adjournment of the meeting at 9:57 p.m.

F. M. Defandorf, *Secretary.*

461ST MEETING OF THE BOARD OF MANAGERS

The 461st meeting of the Board of Managers, held in the Library of the Cosmos Club on February 16, 1953, was called to order by the President, Frank M. Setzler, at 8:05 p.m., with the following in attendance: J. R. Swallen, J. A. Stevenson, J. P. E. Morrison, A. G. McNish, W. H. Gilbert, F. W. Poos, G. F. Gravatt, C. H. Betts, A. H. Scott, L. H. Spindler, Glenn Slocum, F. W. Hough, N. R. Ellis, R. J. Seeger, and, by invitation, E. H. Walker, W. W. Rubey, A. T. McPherson, and J. C. Ewers.

The following Vice Presidents who were not nominated in time for action at the Annual Meeting were unanimously elected: A. G. McNish for the Philosophical Society of Washington, F. O. Coe for the Medical Society of the District of Columbia, and L. H. Spindler for the Helminthological Society of Washington.

The President announced the following appointments for 1953:

Board of Editors of the Journal: Senior Editor, J. P. E. Morrison; R. K. Cook (to January 1956). Associate Editors: D. B. Cowie, David H. Dunkle, and Alan Stone (to January 1956); E. L. Little (to January 1954), replacing Miriam L. Bomhard.

Executive Committee: F. M. Setzler (Chairman), F. M. Defandorf, H. S. Rappleye, W. W. Rubey, Jason R. Swallen.

Archivist: John A. Stevenson (to January 1956).

Committee on Meetings: Watson Davis (Chairman), John W. Aldrich, Austin Clark, D. J. Davis.

Committee on Membership: E. H. Walker (Chairman), Myron S. Anderson, Clarence Cottam, C. L. Christ, John Faber, Angus M. Griffin, D. Breese Jones, Frank C. Kracek, Louis R. Maxwell, A. G. McNish, Edward C. Reinhard, Reese I. Sailer, Leo A. Shinn, Francis A. Smith, Heinz Specht, Horace M. Trent, Alfred Weissler.

Committee on Monographs: W. N. Fenton (Chairman). To January 1956—James I. Hoffman, G. Arthur Cooper.

Committee on Awards for Scientific Achievement: A. V. Astin, General Chairman.

For the Biological Sciences: Herbert Friedmann (Chairman), Harry A. Borthwick, Sara E. Branham, Ira B. Hansen, Benjamin Schwartz, T. Dale Stewart.

For the Engineering Sciences: Samuel Levy (Chairman), Michael Goldberg, E. H. Kennard, E. B. Roberts, H. M. Trent, W. A. Wildhack.

For the Physical Sciences: G. B. Schubauer (Chairman), R. S. Burington, F. C. Kracek, J. A. Sanderson, R. J. Seeger, J. S. Williams.

For the Teaching of Science: M. A. Mason (Chairman), F. E. Fox, Monroe H. Martin.

Committee on Grants-In-Aid for Research: Karl F. Herzfeld (Chairman), Herbert N. Eaton, L. E. Yocum.

Committee on Policy and Planning: To January 1954—W. W. Rubey (Chairman). To January 1956—Eugene C. Crittenden, Alexander Wetmore.

Committee on Encouragement of Science Talent: A. T. McPherson (Chairman). To January 1956—Austin Clark, J. H. McMillen.

Committee of Auditors: Louise M. Russell (Chairman), R. S. Dill, J. B. Reeside.

Committee of Tellers: C. L. Garner (Chairman), Lloyd G. Henbest, M. F. Jones.

The report of the last meeting of the Executive Committee was read:

A meeting of the Executive Committee was held at the home of Mr. Setzler, on February 5, at 8:00 p.m., with F. M. Setzler, F. M. Defandorf, H. S. Rappleye, and J. R. Swallen present.

Mr. Setzler reported on the progress of the index to the Journal. The first galley proof has been received and is being corrected by Paul H. Oehser, of the Index Committee. It is estimated that the index will contain about 350 pages and that the cost of printing will be about $4,500 for 1,000 copies, and $6,000 for 2,000. The price to be charged and the number of copies to be ordered was discussed at length. It was the general opinion that 1,000 copies would be sufficient and that $6 would be a fair price. Some felt that asking a higher price might curtail sales. Every effort will be made to recover the cost of publication through select mailing list advertisement.

It is hoped that the Red Book, in charge of the Executive Committee, will be ready for the printer by the end of April. It will contain data of the Academy and affiliated societies, an alphabetical list of Academy members only, and lists of members under institutions and geographical areas. Data of most of the affiliated societies have already been received, and cards requesting information will be sent to all members in the near future.

The Treasurer presented the tentative budget for 1953, showing estimated receipts of $9,050. After considerable discussion, the proposed budget was approved by the Committee, and is now recommended to the Board of Managers for approval. The breakdown and allotment of these funds are shown on the statement prepared by the Treasurer, copies of which are available for the members of the Board of Managers.

Copies of the proposed budget presented by Mr. Rappleye were distributed to members of the Board of Managers.

Receipts

	1952	*1953 (Estimated)*
Dues	$4,533.25	$4,600.00
Journal subscriptions	1,720.88	1,800.00
Interest and dividends	2,527.84	2,500.00
Sales	169.47	150.00
TOTALS	$8,951.44	$9,050.00

Expenditures

	1952	*1953 (Estimated)*
Journal and Journal Office	$6,569.50*	$7,250.00*
Secretary's Office	555.39	550.00
Treasurer's Office	249.84	300.00
Meetings Committee	451.76	550.00
Membership Committee	9.72	20.00
Archivist	9.00	20.00
Science Fair (1953)	189.20	200.00
Science Calendar (1953–54)	89.09	75.00
Certificates		85.00
TOTALS	$8,123.50	$9,050.00

* Plus charges to authors.

The 1953 budget as recommended to the Board of Managers by the Executive Committee was unanimously approved.

In commenting on the report of the Executive Committee, it was suggested that printing the

Red Book by the offset process be considered and that several bids be obtained. The President indicated it was his desire to recover as much of the cost of the Index as possible from sales and that steps are being taken in regard to advertising.

Chairman A. T. McPHERSON presented the following report:

The Committee on the Encouragement of Science Talent examined all papers entered by students of the Washington area in the Twelfth Annual Science Talent Search conducted by the Science Clubs of America for Westinghouse Educational Foundation. This year, for the first time, students from Maryland and Virginia schools within a 25-mile radius of Washington were included. This arrangement was cleared with the Maryland and the Virginia Academies of Science.

On the basis of original work in their science projects, the following five students are recommended for Certificates of Merit:

JAMES WOODWORTH CONLEY, age 17, 4406 Colesville Road, Hyattsville, Md. Northwestern High School, Project: Application of Modern Principles of Design to Automatic Computations.

WILLIAM ALAN FULLARTON, age 17, 6609 Westmoreland Avenue, Takoma Park, Md. Montgomery-Blair High School, Project: Experiments in Paper Chromatography.

ROSSER A. RUDOLPH, JR., age 17, 2017 North Illinois Street, Arlington, Va. Washington-Lee High School, Project: A Study of *E. coli* Bacteriophage.

WALTER SELDEN SAUNDERS, age 17, R.F.D. 3, Gaithersburg, Md. Bethesda-Chevy Chase High School, Project: A Study of Human Reaction in an Audio Visual Loop.

BENJAMIN BRENEMAN SNAVELY, age 16, 1314 Erskine Street, Takoma Park, Md. Northwestern High School, Project: Measurement of Velocity of Light.

On the basis of having gained Honorable Mention in the national competition, the following two students are recommended for Certificates of Merit:

IRENE ADELAIDE BEARDSLEY, age 17, 3215 Van Hazen Street, NW., Washington 16, D. C. Woodrow Wilson High School, Project: Culture and Curing of Tobacco.

LORETTA MAE REEVES, age 17, 2115 Branch Avenue, SE., Washington 20, D. C. Anacostia High School, Project: Synthesis of Mauve and its Use in Cancer Research.

The Committee recommends that these students be invited to set up demonstrations of their projects in the rear of the assembly room at the time their awards are presented.

The Committee has been asked by the *Washington Daily News* to obtain a news release from the Academy regarding these awards and would like to have instructions from the Board regarding the handling of press relations.

The following members of the Committee participated in reviewing papers and recommending students for the Certificate of Merit: Austin H. Clark, W. T. Read, A. T. McPherson, and Frank M. Setzler, *ex officio*.

The Board approved the seven students recommended by the Committee to receive the Certificate of Merit.

Publicity for meetings of the Academy was discussed, especially in connection with the Academy awards. It was suggested that press releases be prepared and cleared through the Chairman of the Committee on Meetings.

Letters were read from ARTHUR C. CHRISTIE and GEORGE P. WALTON requesting that they be placed on the retired list. The requests were approved as of December 31, 1952. A letter was read from DAVID MINARD, who was elected in March 1952. Because of extenuating circumstances he was able to complete his membership and asked that he be reinstated. The completion of his membership was approved.

A letter was read from the Washington Section of the International Association for Dental Research, through H. J. Caul, chairman of the section, applying for affiliation with the Academy. The application was referred to the Committee on Policy and Planning for recommendation of action by the Board of Managers.

Senior Editor MORRISON reported that sufficient manuscripts were on hand for at least six issues of the JOURNAL. He said that priority will be given to articles on the physical sciences. A brief discussion followed on ways and means of improving the JOURNAL. The Board approved a suggestion by the President that the matter be referred to the Committee on Policy and Planning to determine whether a special committee should be appointed.

Vice President McNISH urged that action be taken by the Academy to equip the Assembly Hall of the Cosmos Club with a moving-picture projector. He suggested the appointment of a special committee to approach the affiliated societies for suggestions and donations.

JASON R. SWALLEN, *Secretary.*

ANTHROPOLOGICAL SOCIETY

The Anthropological Society of Washington held its annual business meeting on January 13, 1953, and elected the following officers: President, MARSHALL T. NEWMAN; Vice-President, WILLIAM H. GILBERT; Secretary, CARL F. MILLER; Treasurer, LUCILE E. HOYME; Councilors to the Board of Managers, JOHN A. JONES (to Jan. 1955), JOHN C. EWERS (to Jan. 1955), MARIAN L. VANDERBILT (to Jan. 1954), SIDNEY ADAMS (to Jan. 1954), JOHN H. COX (to Jan. 1956), and PHILIP DRUCKER (to Jan. 1956); Representative to the Washington Academy of Sciences, WILLIAM H. GILBERT.

A report of the membership and activities of the Society since the last meeting follows: The total membership on January 1, 1953, was 106, a net increase of 8 over a year ago. New members elected during the year totaled 16 and were: Dr. PAUL L. GARVIN, Dr. EDWARD T. HALL, Jr., J. NIXON HADLEY, Dr. HARVEY C. MOORE, JOHN M. ECHOLS, Dr. FRANK G. ANDERSON, MARTHA SCHIFF, Mrs. BARBARA B. HYATT, DOROTHY LIBBY, MARSHALL D. MOODY, GRACE I. BOVE, ARTHUR J. JELLINEK, THEODORE H. HAAS, Dr. MARCUS S. GOLDSTEIN, Dr. WILLIAM NEGHERBON, and MYRON F. LEWIS. Dr. CHARLES L. G. ANDERSON, a former President of the Society, died on December 10, 1952, and 7 members resigned because of their moving from the area.

The report of the Treasurer for the year ended December 31, 1952, follows:

Credit:		
Balance forward	$ 563.87	
Dues collected	140.88	
Dividends, Investment Co. of America	113.30	
Dividends, Mass. Investor's Trust	121.89	
Dividends, Washington Sanitary Housing Co.	20.00	
Dividends, Perpetual Building Association	16.20	
Cosmos Club refund	10.00	
Total		$ 986.14
Expenditures:		
Meetings and speakers	$ 106.20	
Printing and mailing notices	94.39	
AAA dues for Secretary and Treasurer	15.00	
Secretary's expenses	6.38	
Treasurer's expenses	6.33	
Florist's bill	5.10	
Reinvestment, Investment Co. of America	60.45	
Reinvestment, Mass. Investor's Trust	19.44	
Reinvestment, Perpetual Building Association	16.20	
Total		$ 329.49
Balance (in bank)		$ 656.65

Statement of Assets:		
Funds in Perpetual Building Association	$ 552.32	
4 shares Washington Sanitary Housing Co.	200.00	
115 shares Investment Co. of America	1,431.05	
103 shares Massachusetts Investor's Trust	1,935.53	
Cash in Bank	656.65	
Total as of December 31, 1952		$4,775.55
Corrected total as of December 31, 1951		$4,586.68
Increase		$ 188.87

During the early part of the year programs were arranged by Dr. EUGENE WORMAN, then resigning program chairman, and by the President and Secretary. The latter part of the year saw the appointment of a program committee consisting of Drs. JOHN A. JONES and HARVEY C. MOORE. The following is a list of speakers and their topics.

January 15, ALLAN WARGON and Dr. WM. N. FENTON, commentators, *The Longhouse people;* a documentary color film on the Iroquois Indians of Canada.

February 19, Dr. BETTY MEGGERS; *The aboriginal history of Marajo, Brazil* (with kodachrome slides).

March 18, KENNETH E. KIDD; *The quest for Indian trade goods in the Northeast* (with slides).

April 15, Dr. MARTIN GUSINDE, *The Bushmen of the Kalahari Desert, South Africa* (illustrated).

October 21, Mrs. CLAIRE HOLT, *Intercultural communication with peoples of nonindustrial societies.*

November 18, RALPH KEPLER LEWIS, *Bedouin-Village Relationships in the Middle East* (illustrated).

December 16, KERIM KEY, *Cultural changes in rural areas of Turkey.*

Plans for celebrating the 75th anniversary of the founding of the Anthropological Society of Washington in 1954 were discussed at the annual business meeting of the Society, January 13, 1953. It was resolved that a committee be appointed by the President to be designated with the functions of drawing up plans for the 75th anniversary observance and plans for budgeting and investing the Society's capital.

The sum of $25 was voted to be used to further the Washington Science Fair of 1953, provided a report was made by an observer of the Fair to the Society at its next annual meeting.

WILLIAM H. GILBERT, *Secretary*

Officers of the Washington Academy of Sciences

President.................F. M. Setzler, U. S. National Museum
President-elect.................F. M. Defandorf, National Bureau of Standards
Secretary.................Jason R. Swallen, U. S. National Museum
Treasurer.........Howard S. Rappleye, U. S. Coast and Geodetic Survey (Retired)
Archivist.................John A. Stevenson, Plant Industry Station
Custodian and Subscription Manager of Publications
Harald A. Rehder, U. S. National Museum
Vice-Presidents Representing the Affiliated Societies:
- Philosophical Society of Washington.................A. G. McNish
- Anthropological Society of Washington.................William H. Gilbert
- Biological Society of Washington.................Hugh Thomas O'Neill
- Chemical Society of Washington.................George W. Irving, Jr.
- Entomological Society of Washington.................F. W. Poos
- National Geographic Society.................Alexander Wetmore
- Geological Society of Washington.................A. Nelson Sayre
- Medical Society of the District of Columbia.................Frederick O. Coe
- Columbia Historical Society.................Gilbert Grosvenor
- Botanical Society of Washington.................Harry A. Borthwick
- Washington Section, Society of American Foresters.........George F. Gravatt
- Washington Society of Engineers.................C. A. Betts
- Washington Section, American Institute of Electrical Engineers..Arnold H. Scott
- Washington Section, American Society of Mechanical Engineers Richard S. Dill
- Helminthological Society of Washington.................L. A. Spindler
- Washington Branch, Society of American Bacteriologists..........Glenn Slocum
- Washington Post, Society of American Military Engineers......Floyd W. Hough
- Washington Section, Institute of Radio Engineers.......Herbert Grove Dorsey
- District of Columbia Section, American Society of Civil Engineers Martin A. Mason
- District of Columbia Section, Society for Experimental Biology and Medicine N. R. Ellis
- Washington Chapter, American Society of Metals.............John G. Thompson

Elected Members of the Board of Managers:
- To January 1954.................Sara E. Branham, Milton Harris
- To January 1955.................R. G. Bates, W. W. Diehl
- To January 1956.................M. A. Mason, R. J. Seeger

Board of Managers.................All the above officers plus the Senior Editor
Board of Editors and Associate Editors.................[See front cover]
Executive Committee.................F. M. Setzler (chairman), F. M. Defandorf, J. R. Swallen, H. S. Rappleye, W. W. Rubey
Committee on Membership......E. H. Walker (chairman), Myron S. Anderson, Clarence Cottam, C. L. Crist, John Faber, Angus M. Griffin, D. Breese Jones, Frank C. Kracek, Louis R. Maxwell, A. G. McNish, Edward C. Reinhard, Reese I. Sailer, Leo A. Shinn, Francis A. Smith, Heinz Specht, Horace M. Trent, Alfred Weissler
Committee on Meetings.................Watson Davis (chairman), John W. Aldrich, Austin Clark, D. J. Davis
Committee on Monographs (W. N. Fenton, chairman):
- To January 1954.................S. F. Blake, F. C. Kracek
- To January 1955.................W. N. Fenton, Alan Stone
- To January 1956.................G. Arthur Cooper, James I. Hoffman

Committee on Awards for Scientific Achievement (A. V. Astin, general chairman):
- *For Biological Sciences*......Herbert Friedmann (chairman), Harry A. Borthwick, Sara E. Branham, Ira B. Hansen, Benjamin Schwartz, T. Dale Stewart
- *For Engineering Sciences*......Samuel Levy (chairman), Michael Goldberg, E. H. Kennard, E. B. Roberts, H. M. Trent, W. A. Wildhack
- *For Physical Sciences*......G. B. Schubauer (chairman), R. S. Burington, F. C. Kracek, J. A. Sanderson, R. J. Seeger, J. S. Williams
- *For Teaching of Science*..M. A. Mason (chairman), F. E. Fox, Monroe H. Martin

Committee on Grants-in-aid for Research.................Karl F. Herzfeld (chairman), Herbert N. Eaton, L. E. Yocum
Committee on Policy and Planning:
- To January 1954.................H. B. Collins, W. W. Rubey (chairman)
- To January 1955.................L. W. Parr, F. B. Silsbee
- To January 1956.................E. C. Crittenden, A. Wetmore

Committee on Encouragement of Science Talent (A. T. McPherson, chairman):
- To January 1954.................J. M. Caldwell, W. L. Schmitt
- To January 1955.................A. T. McPherson, W. T. Read
- To January 1956.................Austin Clark, J. H. McMillen

Representative on Council of A. A. A. S..................Watson Davis
Committee of Auditors.......Louise M. Russell (chairman), R. S. Dill, J. B. Reeside
Committee of Tellers......C. L. Garner (chairman), L. G. Henbest, Myrna F. Jones

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This Journal is Indexed in the International Index to Periodicals.

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Journal of the Washington Academy of Sciences

This JOURNAL, the official organ of the Washington Academy of Sciences, publishes: (1) Short original papers, written or communicated by members of the Academy; (2) proceedings and programs of meetings of the Academy and affiliated societies; (3) notes of events connected with the scientific life of Washington. The JOURNAL is issued monthly. Volumes correspond to calendar years.

Manuscripts may be sent to any member of the Board of Editors. It is urgently requested that contributors consult the latest numbers of the JOURNAL and conform their manuscripts to the usage found there as regards arrangement of title, subheads, synonymies, footnotes, tables, bibliography, legends for illustrations, and other matter. Manuscripts should be typewritten, double-spaced, on good paper. Footnotes should be numbered serially in pencil and submitted on a separate sheet. The editors do not assume responsibility for the ideas expressed by the author, nor can they undertake to correct other than obvious minor errors.

Illustrations in excess of the equivalent (in cost) of one full-page halftone are to be paid for by the author.

Proof.—In order to facilitate prompt publication one proof will generally be sent to authors in or near Washington. It is urged that manuscript be submitted in final form; the editors will exercise due care in seeing that copy is followed.

Unusual cost of foreign, mathematical, and tabular material, as well as alterations made in the proof by the author, may be charged to the author.

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300	9.75	19.50	29.25	39.00	48.75	10.50
400	13.00	26.00	39.00	52.00	65.00	14.00

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Single numbers	.25

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Remittances should be made payable to "Washington Academy of Sciences" and addressed to the Treasurer, H. S. RAPPLEYE, 6712 Fourth Street, NW., Washington 12, D.C.

Exchanges.—The Academy does not exchange its publications for those of other societies.

JOURNAL
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WASHINGTON ACADEMY OF SCIENCES

Vol. 43 September 1953 No. 9

ARCHEOLOGY.—*Additional information on the Indian pottery from Pissaseck (Leedstown), Westmoreland County, Virginia.*[1] Carl F. Miller, Bureau of American Ethnology.

After the death of David I. Bushnell, Jr., in 1941, a number of sherds marked "From Leedstown, 1936" were found among his possessions. These turned over to the Smithsonian Institution. It is assumed that the sherds, U. S. N. M. nos. 392206–7, were collected from the surface of a village site in or near Leedstown, Westmoreland County, Va.

Previously, Bushnell (1937) published on 12 sites below the falls of the Rappahannock River in Virginia, one of which is of special interest in that it deals with the material on hand—this is the village of Pissaseck upon which a portion of Leedstown was later built. Inasmuch as his pottery description of this site is rather meager, the collection warranted further study in order to point out the correlation with surrounding types of the same chronological age.

Pissaseck, as the village site was known during early colonial times, was a large aboriginal settlement. It stood on the north bank of the Rappahannock River and was represented by Capt. John Smith (1884) on his map of 1624 with a "Kings Howse" to show its relative importance. This village was not mentioned in the earlier narratives of 1608 when Smith and his party went up the river. Smith's map of 1624 indicated a number of villages occupying position along the Rappahannock River which were no longer evident when Hermann (SEE: Bushnell, 1937, p. 11) mapped the same area in 1673. Thus, just a little over 50 years after Captain Smith had been conducted by his Indian captors to their settlements on the banks of the Rappahannock, the native population of the entire valley had been dispersed and many of their village sites had become the property of English settlers.

Using Tooker (1911), a self-styled Algonkinist, as a source of information, an attempt was made to determine the meaning of the word "Pissaseck." It was found that the suffix "seck" is mostly spelled "suck," which has been interpreted to mean "brook," "creek," "outlet," or "a small stream flowing out of a pond." The stem of the word, "piss," was interpreted to mean either a "mire," "meadow," or "marsh." Knowing that the village was located on a level area above the river, below and adjoining an extensive marsh, known as Drakes (Drake's) Marsh, presents a clue as to the possible suggested meaning of the word. From the above study, the possible suggested meaning may be: *the place where the marsh empties into the river.*

Smith noted that Pissaseck occupied a level area above the river, below and adjoining an extensive marsh, known as Drakes Marsh, where there was much game and wildfowl to be found. Vast amounts of broken pottery and innumerable objects of stone covered the surface of this area. The description conforms to one made by Strachey (1849). He tells us that:

> Their habitations or townes are for the most part by the rivers, or not far distant from fresh springs, commonly upon a rive of a hill, that they may overlooke the river, and take every small thing into view which sturrs upon the same. Their howses are not many in one towne, and those that are stand dissite (dispersed) and scattered without forme of a street, far and wyde assunder.

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[1] Published by permission of the Secretary, Smithsonian Institution.

In going over the early records of this section of Virginia, we find allusions to the Iroquois bringing pressure to bear upon the small loosely grouped Algonquian towns causing them to move into more concentrated areas for mutual protection. The intrusion of white man's settlements hastened this regrouping and later final abandonment. The Iroquois were pushing them around in 1608 and by 1624 the village was well established only to be abandoned some time before 1673.

The area of the falls of the Rappahannock River formed "the bounds betwixt the Kingdome of the *Mannahocks* and the *Nandtaughtacunds*." Apparently the *Mannahocks* were the better known *Manahoac* tribes which have been assigned to the *Siouan* group, while the *Nandtaughtacunds* formed a part of the *Powhatan Confederacy* which were of *Algonquian* stock. The territory occupied and claimed by the Algonquian group in Virginia included the tidewater section from the Potomac south to the divide between Jamestown Island and Albemarle Sound, N. C., and extended into the interior as far as the falls of the principal rivers about Fredericksburg and Richmond. To the west of them in the Piedmont region were the hostile *Monacan* and *Manahoac*, while to the south were the *Chowanoc, Nottoway*, and *Meherrin* of Iroquoian stock. It seems that no considerable number of the Powhatan Indians ever removed from the general tidewater area of the Chesapeake Bay. Apparently they just gradually died out or retired into one or two small reservations where a number of mixed-bloods still live.

Bushnell (1937) indicated that by the latter part of the seventeenth century the English traders were probably well established in the town of "Leeds" at or near the Indian village of Pissaseck. It was during the meeting of the General Assembly that convened at Williamsburg, Va., in May 1742 that an Act was passed for the establishment of a town "on the north side of the Rappahannock River in the County of King George, where the church and public warehouses are built . . . The said town shall be called by the name of Leeds."

Later Leeds became known as Leedstown. It was an active center of trade, with wharves and warehouses from which vast quantities of tobacco and other products of the colony were sent to England and where sailing vessels landed supplies for the rich plantations on the Northern Neck.

> Scant traces of the colonial town remain, and these are now encountered intermingled with the stone implements and bits of earthen vessels made and used by the earlier occupants of the region. However, the brick structures erected in the town covered only part of the land that had formerly been included in the native settlements, assuming the site to have been occupied and reoccupied through generations, long before the coming of the English. (Bushnell, 1937, p. 18.)

ARCHEOLOGY

Holmes (1903), in his study of Algonquian pottery, thought that this pottery was developed mainly in the general region from a common source and was manufactured by all members of the Powhatan Confederacy as well as other members of the same stock along the Carolina coast. He suggested that environment may have played a large part in the rate of its development resulting in a tendency of keeping it rather simple in form and uniform throughout the whole Algonquian cultural area. Why a group who was relatively skillful in other arts, such as the cultivation of maize, etc., should keep their pottery-making in such a simple form is rather hard to explain. By "simple form" we mean that all vessel types were confined to deep bowls and wide mouthed pots of medium to small size. Holmes (1903) further states:

> Save in remote sections where western and southern tribes are known to have wandered, we do not encounter such features as eccentric or compound forms, animal shapes, constricted mouths, high necks, handles, legs, or flat bases of any kind. Ornament is archaic, and curved lines are almost unknown. These statements are in the main true of the whole Atlantic Algonquian belt from Albemarle Sound to the Bay of Fundy.

Even though the ware was simple in form and decorated with archaic-looking methods it was well made and shaped. Supposedly the vessels are largely if not exclusively culinary in nature.

A fair number of sherds demonstrates that the ware was manufactured by means of

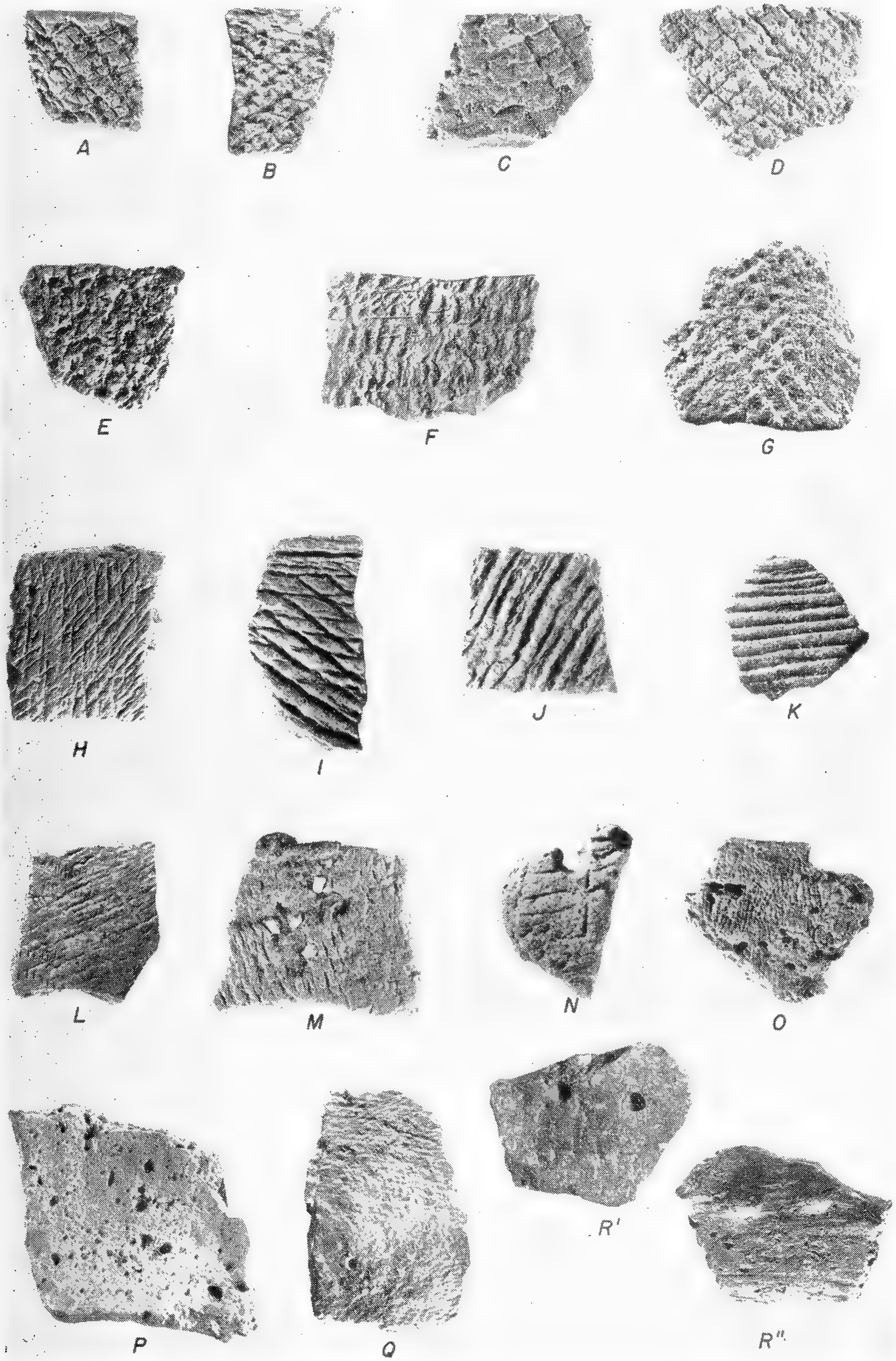

Fig. 1.—Sherd types from Pissaseck (Leedstown), Va.: Net-impressed A–E; Fabric-impressed F, G, O, and Q; Cord-wrapped paddled H–N; Plain P, R′, and R″.

coiling and that a uniform thickness throughout the vessel is not the usual result. Thickness varies from place to place within the same body wall. As a rule the bases are medium thin with the adjoining walls thickest tapering in thinness as the lip area is approached. Local clays were utilized throughout the area with a wide range of ingredients used as tempering material. Whether type of temper has any stratigraphic significance is not known at this time. Tempering material consists of sand, large particles of grit, pulverized limestone and just a trace of crushed shell. Sand particles vary in size from very fine, less than 1.0 mm in diameter, to comparatively coarse particles of grit or gravel which ranged from 4.0 to 5.0 mm in diameter. In some cases the grit and gravel particles were so large that they occupied the whole of the wall thickness.

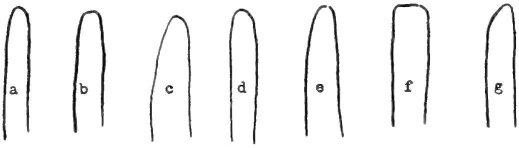

FIG. 2.—LIP FORMS: Cord-wrapped paddle—sand tempered. *f* had faint cord impression on the lip area.

Color, caused by firing, ranges from a light buff into a reddish brown and into a chocolate-gray, indicating either a reduced or an oxidized condition during this stage of manufacture. Evidences of fire clouds are found on the exterior of sherds.

As far as we can tell from the sherds, the surfaces were smoothed while the vessels were still in the plastic state. After this any subsequent exterior treatment was performed, such as impressing fabrics or textiles into the surface of the vessel so as to decorate or ameliorate it.

Lips, in all instances, are simple being either rounded or flattened with gradations between the two showing on a single specimen. One sherd has a scalloped edge formed by pressing a medium heavy cord into the soft walls of the vessel at intervals roughly about an inch apart. Such treatment is the exception rather than the rule and is not characteristic of the whole assemblage.

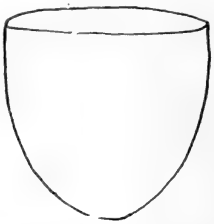

FIG. 3.—Principal vessel shape as restored from sherds.

Rims are slightly modified for the esthetic effect. One modification that occurs in the fabric-impressed ware was found on the interior of the rim where a number of trough impressions were arranged side by side at the top of the vessel. These individual impressions are arranged in a row and appear to have been made by pushing the tip of the finger into the moist clay so that a line of semicircular depressions were raised on the side of the vessel toward which the force was applied. Other samples show further modification in that this pinched effect has been smoothed down eradicating the ripple effect leaving a slight bevel instead. As a consequence the lip area is thinner than the wall of the neck area. No folding or collar effects in the neck area are present.

A number of measurements were taken to determine the over-all size of the orifice of various vessels represented within the collection. It was found that they averaged around 9 inches (22.7 cm) in diameter with some smaller and some larger. In this same manner, the average body diameter and depth were determined. It was found that the diameter varied very little from the average diameter of the mouth opening, while the mean depth was around 11 inches (28.0 cm). Estimating from these measurements we would judge the volumetric content of an average vessel to be around 2 gallons, with some of the smaller ones holding around 2 quarts.

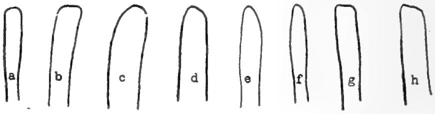

FIG. 4.—LIP FORMS: Plain ware, *a*—shell tempered; *b*—limestone tempered; *c*—*h* sand tempered.

We find that the Algonquian was given to the use of cordage and textile fabric impression as a means of embellishing his vessels—either intentional or accidental. Generally, the entire body of the vessel is covered with impressions of either coarse cloths, various texture of nets or cords. Besides the textile impressions there a few cases in which punctations occur, Fig. 1, R′. These punctations are rather large, diameter 6 mm, which almost pierce the exterior walls of the vessel leaving a node or pustule opposite each separate punctation on the interior of the vessel, Fig. 1, R′ and R″. Similar punctations have been reported for other sections of the eastern seaboard.

SUMMARY AND CONCLUSIONS

As near as we could determine, the pottery recovered from Pissaseck was manufactured by means of coiling and some molding out of local clays. A number of fractures along the original coils clearly demonstrate the method of manufacture. This was further demonstrated when small fragments or sections were broken off each sherd to test for tempering. In a number of cases these breaks occurred at the juncture of the two coils. The pottery was developed mainly in the general region from some unknown origin and was made by all members of the Powhatan Confederacy and to some extent by outside groups coming under their influence.

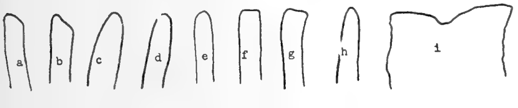

FIG. 5.—LIP FORMS: Net-impressed wares; all are sand tempered. "*i*" shows scalloped edge. Slight cord impressions occurred on: *a*, *d*, and *h*.

In testing for temper each individual sherd was freshly broken in order to examine an unweathered rather than a long exposed surface. Four different types of tempering materials were identified: sand, crushed quartz, crushed limestone and crushed shell with but small emphasis on particles of water worn gravel. The majority of the sherds were tempered with either sand or crushed quartz (grit), next to be followed by crushed limestone while crushed shell was just barely represented. Of the latter two, most of the tempering material had leached away leaving only the impressions of the original material and as a consequence all sherds thus effected were filled with a number of holes. This feature makes the sherd fragments comparatively light in weight. Sand particles are usually small with rounded edges. The actual amount of sand used readily determines that the roughness of the paste is in direct ratio to the amount of sand used as tempering material. Crushed quartz, or grit, varies in diameter from 1 to 5 mm. In the latter case some particles of the larger size have been noted to occupy the complete thickness of the body wall of the vessel and can readily be recognized on the interior as well as the exterior wall. This characteristic is demonstrated in Fig. 1, M.

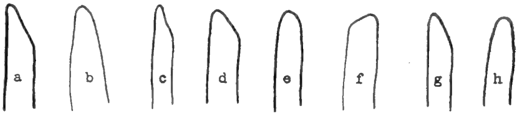

FIG. 6.—LIP FORMS: Fabric-impressed ware. *a*, *c*, and *g* have been modified by pinching. Slight nodes are present on the interior surface formed by pinching on *a*. *c* and *g* have been smoothed. Interior surfaces are represented to the right on each profile.

Again, we say that the color ranges from a light buff through light orange through grays and in one instance is a real dark gray or black.

As a rule, after the vessel was fashioned, the surfaces were roughly smoothed. In the decorated wares and various impressions were next applied to the exterior only and the vessel allowed to dry before firing. While the vessel was still plastic any other alterations such as finger pinching on the interior rim of the vessel, beveling of the rim area in the interior of the vessel, as well as giving the rim a scalloped effect was then performed.

Decoration, if truly it was thus, consists of the impressing of various sized nets, fabrics, cords, and baskets on the exterior of the vessel. In addition, a cord-wrapped paddle was used to apply the impressions of parallel arranged sections of cords to the exterior.

Bushnell (1937) tells about one sherd which was found at Pissaseck "decorated with straight, very regular lines, which had been made by impressing some hard material into the clay when the latter was in a plastic state." This technique has been termed "simple stamping" and is illustrated in his plate 7, *a*. It appears that this sherd was tempered, at one time, with crushed limestone which had leached away leaving a surface similar to Fig. 1, P.

Funkhouser and Webb (1929, pp. 86–102) noted five different types of materials utilized to impart this simple stamping technique to exteriors of vessels. These are: shredded fibrous bark, stems and leaves of some of the tough wiry grass, flat strips of bark, flat pieces of corn husk or stalk, and narrow strips of skin or leather. They listed additional material thus used which include: pawpaw, Indian hemp, milkweed, cat tail, rushes, and inner bark of leatherwood or moosewood, linden or basswood, rattlesnake master and canary grass.

Bushnell (1937) illustrates a number of textile types identified from pottery fragments from Nandtanghtacund which are almost identical to those recognized on the sherds from Pissaseck. Comparable surface treatment is to be found through the Algonquian area with slight modification noted in borderline areas.

Rims are usually straight with only an occasional one showing a slight incurving of the exterior wall. Rims are usually of the same thickness as the body wall; in only three instances are they thinner than the wall. A distinct rim modification appears in the form of medium large punctations which form nodes or pustules within the throat section of the vessel.

Lips, as a rule, are very simple either rounded, flattened and sometimes beveled. Only rarely has the impression of cords carried over onto this area of the vessel. Of all the lips in the collection only one has been fashioned into a scalloplike appearance. This was brought about by impressing into the plastic clay a cord whose impression is to be found in the troughs of the scallop.

The typical body form is cylindrical and tapering down to a rounded base. The body is not of uniform thickness, as thickened portions appear throughout the vessel. Bases are no thicker than the average wall.

All specimens in the present collection, after they were separated into the various decorative types, were measured for thickness. Plain sherds, which may have originally formed the basal portions of decorated vessels, ranged from 3 to 13 mm, with a mean of 8 mm; net-impressed ranged from 5 to 11 mm with a mean of 7.5 mm; cord-wrapped paddle, taken as a whole irrespective of the diameter of the elements, ranged from 4 to 12 mm with an average of 8 mm; fabric-impressed ranged from 5 to 12 mm with an average of 8.5 mm.

The type of pottery found here is characteristic of the Algonquian groups found north to the Bay of Fundy, between Nova Scotia and New Brunswick, Canada, and south to Albemarle Sound in North Carolina. The southern portion extended westward to the falls of the principal rivers around Clarksville, Fredericksburg, and Richmond, Va. This wide range will allow for a number of local variants. It is believed that the pottery types found along the Rappahannock belong to this general classification. It is also felt that certain influences coming in from the Ohio Valley may have influenced it to some extent.

On one plain sherd there is the appearance of the use of a red slip both interiorly and exteriorly. Under magnification it appears as a thin light red layer 0.25 mm in thickness with no penetration into the core of the sherd. The slip is much thicker on the exterior than it is on the interior and appears as though it was brushed on lightly over this surface. The sherd is tempered with moderate sized grains of sand. The slip has been rubbed somewhat, but was not polished.

There is no direct evidence of the use of handles or lugs of any description on the pottery from this area. Bushnell (1937) illustrates a handle in his plate 7, *b*, which could have been an importation from farther west since such features are customarily found along the headwaters of the James.

It would appear that the ceramic trend of the sites along the Rappahannock River was toward a transition from purely early Woodland into an early aspect of Algonquian tradition which may be termed a late phase of late Woodland. This is paralleled in the tempering material which is sand and grit in the early stages and crushed limestone and shell in the later ones. Up to this stage there is no complexity in vessel shapes and form, and such embellishments as lugs, handles and feet are lacking.

TECHNOLOGICAL AND ARTISTIC ACTIVITY

POTTERY COMPLEX:

- Manufactured by means of the coiling system
- Manufactured by molding, rare
- Tempered with:
  - Sand
  - Crushed quartz (Figure M)
  - Crushed limestone (Figure P)
  - Crushed shell, rare
- Deep bowl shapes dominant
- Wide-mouthed jars, present
- No handles, lugs or feet
- Lips are simple
- Rims are straight
- Rims occasionally partially punctuated with nodes or pustules on the interior, throat area, of vessels (Fig. 1, R′, R″)
- Drill holes below lips (Fig. 1, N)
- Net-impressed (Fig. 1, A, B, C, D, N)
- Fabric-impressed (Fig. 1, G, O. Q)
- Cord-wrapped paddle impressed (Fig. 1, H, I, J, K, L, M)
- Plain smoothed (Fig. 1, P, R″)
- Basket impressed (Fig. 1, F)

LITERATURE CITED

BUSHNELL, DAVID I., Jr. *Indian sites below the falls of the Rappahannock, Virginia.* Smithsonian Misc. Coll. **96:** no. 4. 1937.

FUNKHOUSER, W. D., and WEBB, W. S. *The so-called ash caves of Lee County, Kentucky.* Reports in Archaeology and Anthropology **1**(2): 86–102. Lexington, 1929.

HENNING, WILLIAM WALLER. The Statutes at Large; being a collection of all the laws of Virginia from the first session of the Legislature in the year 1619. Vol. 5, pp. 193–197. 1823.

HERMANN, AUGUSTINE. (See: Bushnell, 1937.)

HOLMES, W. H. *Aboriginal pottery of the eastern United States.* 20th Ann. Rep. Bur. Amer. Ethnol. 1903.

SMITH, JOHN. *The generall historie of Virginia, 1624.* (All references to Smith's writing are quoted from the English Scholar's library edition.Edited by Edward Arber, Birmingham, England, 1884.)

STRACHEY, WILLIAM. *The historie of travile into Virginia Britannia.* Hakluyt Society, London, 1849.

TOOKER, WILLIAM WALLACE. *The Indian place names on Long Island and islands adjacent.* New York, 1911.

WEBB, WILLIAM S., and FUNKHOUSER, W. D. *Rock shelters in Menefee County, Kentucky.* Reports in Archaeology and Anthropology **3** (4). Lexington, 1936.

PALEONTOLOGY.—*The morphology and classification of the oldhaminid brachiopods.* ALWYN WILLIAMS,[1] Glasgow University. (Communicated by G. Arthur Cooper.)

The grotesque nature of that short-lived but widespread group of brachiopods including *Oldhamina* Waagen and *Leptodus*[2] has long been a source of palaeontological interest and has led to many conflicting interpretations of the morphology and habit. Before Waagen's masterly exposition (1887) of the morphology and affinities of the group the occasional specimen obtained from the marine Permian of China and India were so confusing that de Koninck described *Oldhamina* as a bellerophon and Kayser named *Leptodus* in the belief that it represented part of a fish skeleton.

In the past 50 years a number of important papers, notably by Fredericks (1925), Watson (1917), Wanner (1935), and Licharew (1932), have not only substantiated Waagen's conclusions but also added greatly to our knowledge of the diversification and derivation of the group so that now there is no doubt that although the oldhaminids are exceptional in a number of characteristics they were derived from the normal strophomenoids and are but unusual members of that group.

Oldhaminid peculiarities are manifold. The shell is disproportionately inequivalve, the hinge-line together with the articulatory apparatus is rudimentary and the muscles (as judged from the muscle scars) were correspondingly degenerate and often asymmetrically developed, the brachial valve

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[1] I record with pleasure the stimulating and helpful discussions I have had with Prof. T. N. George and Mr. G. Owen, both of Glasgow University, on the subject matter of this paper.

[2] The use of *Lyttonia* Waagen, 1887, in place of *Leptodus* Kayser, 1883, is without warrant.

is typically highly lobate and the pedicle valve equipped with a complementary septal apparatus. But unusual as these features are the shell structure of the brachial valve appears to be the most radical departure from that of normal brachiopods.

SHELL FORM AND STRUCTURE

In all articulate brachiopods the shell, excluding the periostracum, is composed of two layers, an outer lamellar layer of constant thickness consisting of a mosaic of calcitic platelets and an inner fibrous layer of variable thickness built up of fibrous calcite. Work on the relationship between the shell and mantle in modern *Terebratulina* to be published jointly with G. Owen in the near future has shown that the differentiation of the shell layers begins at the mantle edge (Pl. 1, Fig. 1). The lamellar layer is deposited only by a few epithelial cells forming the tip of the outer lobe, the deposition of the fibrous layer begins immediately behind this narrow lamellar zone and is carried on to a varying degree by the outer epithelial layer of the mantle over the entire shell surface. Thus all internal processes and protuberances such as the terebratuloid loop are composed only of fibrous calcite and are deposited by enveloping invaginations of the outer epithelial layer of the mantle.

The shell of the oldhaminid pedicle valve (Pl. 2, Figs. 6, 7) is like that of any other brachiopod. It consists of an outer lamellar layer, and an inner fibrous layer traversed as in all strophomenoids by spicules of cryptocrystalline calcite which do not penetrate the lamellar layer but protrude through the innermost fibrous layers to give the internal shell surface a tuberculate appearance.

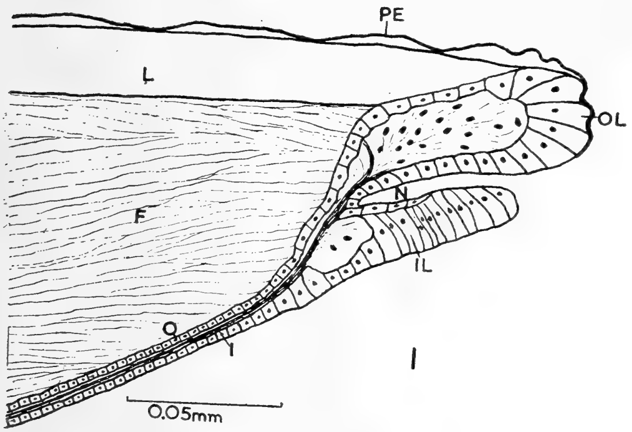
The brachial valve (Pl. 2, Fig. 2) however appears not to possess this twofold differentiation of the shell, for the outer lamellar layer is almost completely absent, the entire shell anterior to a small apical triangular area being composed only of fibrous calcite so that the external and internal surfaces are pierced by spicules. The absence of the lamellar layer over so large an area is not known in any other brachiopod and calls for a reinterpretation of the nature and growth of the brachial valve.

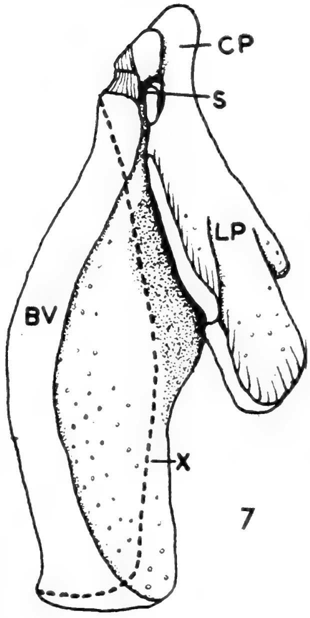
If analogy with modern terebratuloids is valid and in strophomenoids, too, those structures which are composed only of fibrous material were deposited within invaginations of the outer epithelium, then that part of the oldhaminid brachial valve which is also composed of fibrous calcite was strictly internal and formed no part of the protective shell. In this event most of the structure hitherto identified as the brachial valve is no more than an internal skeletal support to a highly lobated mantle infold.

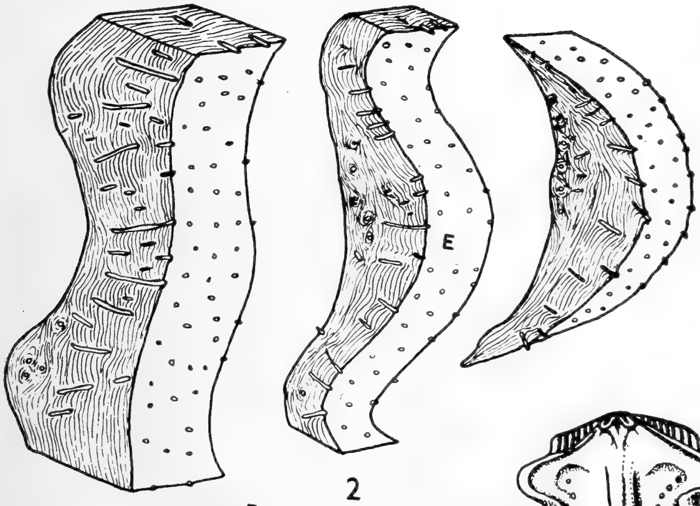
The brachial valve which in normal brachiopods is a part of the enclosing protective covering to the viscera and mantle is thus vestigial and obsolescent. It is represented by the small obtusely triangular portion of the shell situated apically and consisting of the usual outer lamellar layer and inner fibrous layers. It forms only the lobes of the degenerate cardinal process and the posterior part of the denticular sockets (Pl. 1, Figs. 3–5).

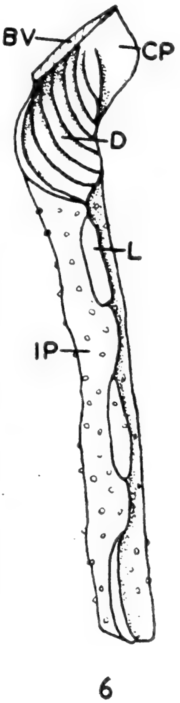
This interpretation is not as far-fetched as first impressions convey. Comparable developments in the strophomenoids are found in both the thecideids and the plectambonaceids whose strongly elevated platforms, deposited by the outer epithelium, are developed for the support of the lophophore. In the plectambonaceid *Leptelloidea musca* Öpik (cf. Figs. 6, 7 of Pl. 1) the lophophore platform is so pronounced that it protrudes well into the interior for over half the length of the shell as a bilobed pseudopunctate plate diverging from the brachial valve just anterior to the cardinalia. The difference between such a development and that of the oldhaminids lies in the disproportionate size of the oldhaminid internal plate in comparison with the brachial valve the growth of which was arrested at an early stage of development.

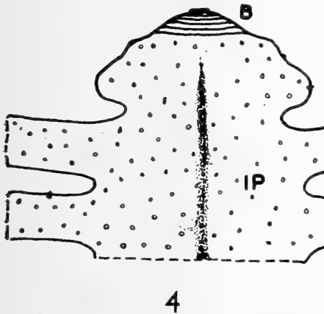
The extraordinary development of the oldhaminid brachial valve and internal plate possibly occurred in the following manner. During the earliest stages of growth both lamellar and fibrous layers were laid down by the mantle which advanced from an initial locus of growth lying immediately posterior to the cardinal process and expanded laterally to cover an obtusely triangular area. Such a structure is reminiscent of an obsolescent interarea and chilidium but hardly homologous with them for the direction of growth was the reverse of that governing the deposition of a true interarea and chilidium. The mantle edge did not advance beyond the base of the triangular lamellar layer; but as growth proceeded the outer epithelial layer continued the enlargement of the incipient cardinalia and an inwardly directed plate-like ridge, the latter

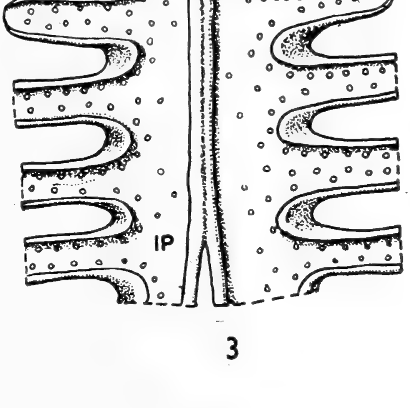












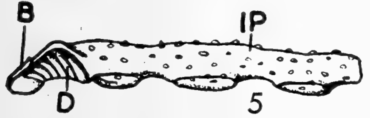


PLATE 1

FIG. 1.—Radial section through the mantle edge of *Terebratulina* sp., Crinan Loch, Scotland, showing the relationship between the shell and the mantle lobes: F, fibrous layer; I, inner epithelium; IL, inner lobe; L, lamellar layer; N, setal groove; PE, periostracum; O, outer epithelium; OL, outer lobe.

FIG. 2.—Structure of a lobe of the brachial internal plate of *Oldhamina decipiens* Koninck as reconstructed from serial sections of specimen BM. 18646, Permian, Salt Range, India: I, internal surface; E, external surface. (× 10)

FIGS. 3–5.—Internal, external, and lateral views respectively of the posterior portion of brachial valve and internal plate of *Leptodus* sp. Permian (Word), W. Texas: B, vestigial brachial valve; D, sockets for dental areas; IP, internal plate. (× 3)

FIG. 6.—Enlargement (× 6) of Fig. 5 for comparison with Fig. 7 representing a lateral view of *Leptelloidea musca* Opik, Middle Ordovician, Baltic Provinces (× 7): BV, brachial valve; CP, cardinal process; D, socket for dental areas; IP, internal plate; L, lobe; LP, lophophore platform; S, socket; X, external profile of brachial valve.

encased in an epithelial sac, expanding anteriorly to form the internal plate. General oldhaminid morphogeny would lead in the subsequent development of the internal plate to the early appearance of a median incision by the accelerated growth of the submedian areas, and later, in phylogeny as well as ontogeny, the appearance of the lateral lobes.

In addition to imparting rigidity to the infold of the dorsal mantle, the internal plate probably gave support to the lophophore, a conclusion already advocated especially by Watson (1917) and Wanner (1935). The most primitive oldhaminid known is the upper Pennsylvanian *Poikilosakos* Watson, immature specimens of which possess a subcircular internal plate with a median incision (cf. *Cardinocrania* Waagen). If the lophophore was adherent to the periphery of such a plate it closely resembled the schizolophus so characteristic of many brachiopods. Moreover if the lobation of the internal plate was accompanied by a corresponding lobation of the lophophore it assumed the familiar pattern of the ptycholophous stage.

The shell composition of the oldhaminid brachial valve then, suggests that the brachial valve proper is a vestigial apical triangular structure, whereas the greater part of the shell consists of a lobated plate ensheathed in mantle tissue and giving support during life to a schizolophous or ptycholophous lophophore. The oldhaminid brachiopods were therefore functionally univalves (Pl. 2, Fig. 8).

The oldhaminid pedicle valve was normally developed to form a protective covering to the viscera and the ventral mantle lobe by which it was deposited; although it must be noted that, since the brachial valve and associated internal plate lay well within the periphery of the pedicle valve, a considerable area of the mantle must have been exposed.

The structure of the posterior portion of the pedicle valve is however exceptional. The apex of the valve is usually malformed through attachment, but it is evident that in place of an interarea there existed a small triangular patch of lamellar calcite which lay immediately posterior to the vestigial brachial valve (Pl. 2, Figs. 3, 4). This triangular patch forms the posteromedian area of an enormous flap of fibrous and lamellar shell material apparently representing an extension of the posterior part of the pedicle valve and invariably sharply reflexed just dorsal of the base of the triangular lamellar layer. The shape of the flap varies considerably: specimens attached to a regular surface possess a flap which resembles a pair of expanded ears extending laterally from the median reflexed area (Pl. 2, Fig. 5); in those which lay free on the sea floor throughout most of their lives the flap is greatly extroverted so that the distal edge is usually in contact with the external surface of the pedicle valve (Pl. 2, Fig. 1); in those attached to irregular surfaces or crinoid stems the flap is closely adherent and moulded to the base (Pl. 2, Fig. 3); and in two distinct stocks, *Chaoella* and *Adriana*, the flap grew forward and is anky-

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PLATE 2

FIG. 1.—Submedian portion of the posterior flap of *Oldhamina decipiens*, reconstructed from serial sections of BM. 18646, Permian, Salt Range, India: 1, 2, 3, 4, and 5 are successive layers of shell deposited by the posterior flap, the circles (R) represent the minimum point of retractibility of the mantle flap necessary for the deposition of each succeeding layer; D, dental area; L, lamellar layer; P, pseudopunctate fibrous layer; PV, pedicle valve; T, triangular area of lamellar calcite. (× 9)

FIG. 2.—Submedian view of interior of pedicle valve of *Chaoella* sp., Permian (Leonard) W. Texas: L, lamellar layer; P, pseudopunctate fibrous layer; PF, posterior flap; PV, pedicle valve; T, triangular area of lamellar calcite. (× 2.5)

FIGS. 3, 4.—Submedian and posterior views of the apical part of the pedicle valve of *Leptodus* sp., Permian (Word), Texas: D, dental area; L, lamellar layer; P, pseudopunctate fibrous layer; PF, posterior flap; PV, pedicle valve; R, reflexed region of posterior flat; T, triangular area of lamellar calcite. (× 3)

FIG. 5.—Apical part of pedicle valve of *Leptodus* sp., Permian (Word) Texas: D, dental area; PF, posterior flap; PV, pedicle valve. (× 3)

FIGS. 6, 7.—Portion of septal apparatus of *Leptodus* cf. *richthofeni* Kayser, Permian (Sosio), Sicily and *Oldhamina decipiens*, Permian, Salt Range, India respectively, reconstructed from serial sections: L, lamellar layer; F, pseudopunctate fibrous layer. (× 8)

FIG. 8.—Submedian view of a reconstruction of a *Leptodus* to show the relationship between the mantle and the shell (portrayed in solid black in section): C, cirrus of schizolophous lophophore; EM, exposed part of the ventral mantle lobe (M); IP, internal plate enveloped by an infold of the dorsal mantle lobe; PF, retractible posterior flap; V, visceral region.

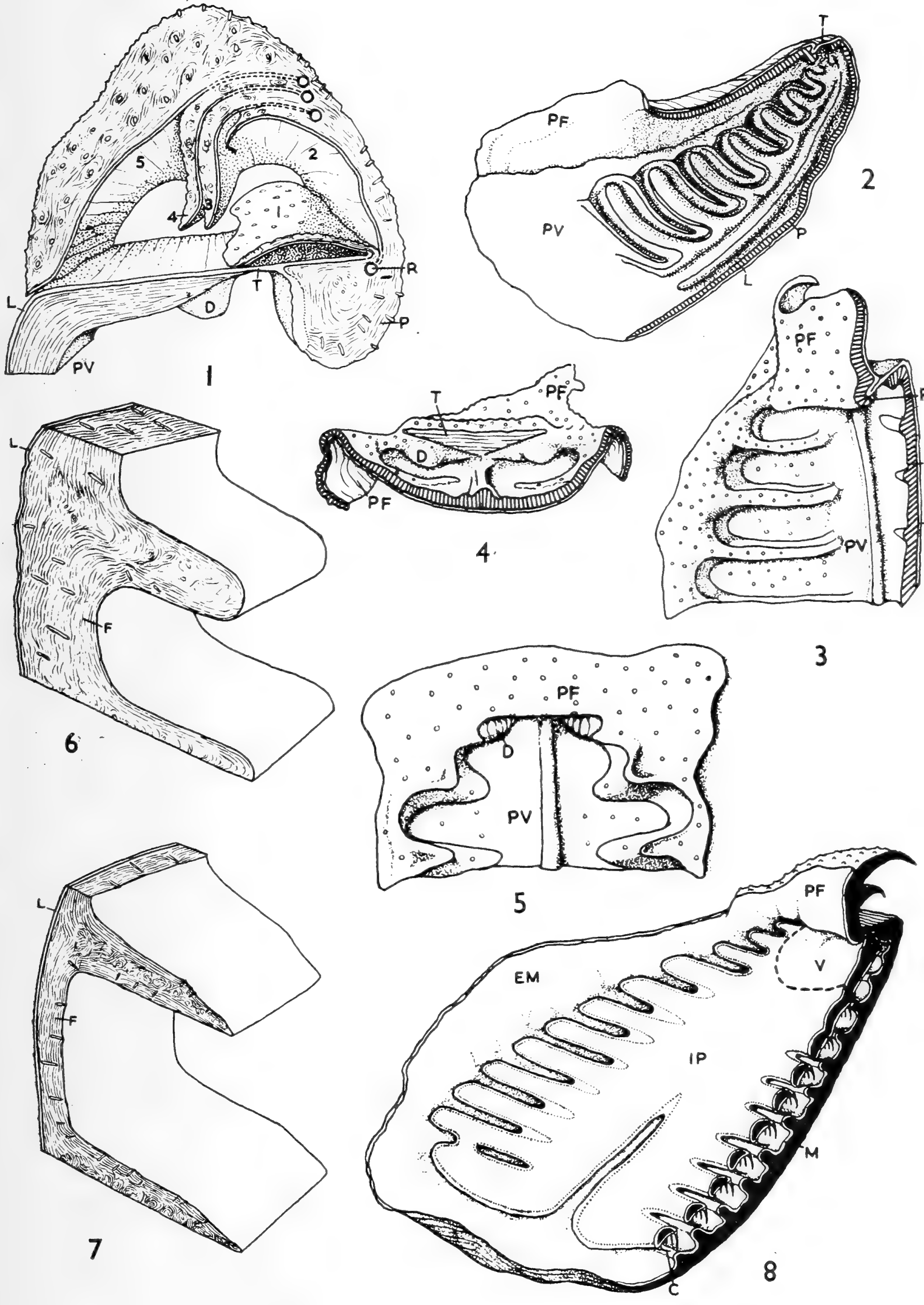

Plate 2.— (See opposite page for legend).

losed to the sides of the pedicle valve to form a deep cone (Pl. 2, Fig. 2).

The posterior flap, although apparently an integral part of the pedicle valve, lies dorsal to the brachial valve and was the prime organ of fixation (indeed the only one in those oldhaminids attached to crinoid stems). It is envisaged as having been laid down by a posterior extension of the mantle capable of a rapid deposition of cementing shell material and disposed in such a way that the inner epithelial layer was invariably exposed. This posterior mantle flap was highly variable in shape, moulding itself closely to the base of attachment and it must be concluded that the mantle was greatly retractible so that paper-thin layers of shell consisting of both fibrous and lamellar calcite could be plastered one on top of another (Pl. 2, Fig. 1).

The origin of the posterior mantle flap is unknown, for no homologue is known to exist in other brachiopods; but it is a constant feature of all oldhaminids and is as prominent in primitive forms like *Poikilosakos* as it is in later Permian forms.

THE ARTICULATORY APPARATUS

If these conclusions on the form of the shell are acceptable it is not surprising to find that the leptodid articulatory apparatus is degenerate.

The cardinal process is undoubtedly bilobed but is usually rather inconspicuous in marked contrast to the pronounced development of the structure among strophomenoids generally. Anterolaterally to the cardinal process lie a pair of concave surfaces oval in outline and extending down to the first pair of lateral lobes. These surfaces are usually striated and represent sockets for the reception of a pair of similarly striated slightly convex surfaces (dental areas of Watson, 1917, p. 213) in the apical region of the pedicle valve.

The fact that the muscle scars are usually asymmetrically and sporadically impressed has been fully discussed by paleontologists. Well preserved interiors of the brachial valves sometimes bear a pair of variably defined impressions anterior to the cardinal process which have been taken to be the adductor scars. Occasionally too a full complement of diductor and adductor scars may be seen in the postero-median region of the interior of the pedicle valve (e.g., *Poikilosakos variabile* Wanner and Sieverts, 1935); and it seems that the diductors, when normally disposed, were inserted in a pair of narrowly divergent depressed areas sometimes bounded by ridges and lying lateral to submedian adductor scars. These scars however are frequently unequally developed and asymmetrically disposed. In *Poikilosakos petaloides* Watson and *Oldhamina decipiens* (de Koninck) as figured by Noetling (1905) the left adductor scar is rudimentary compared with the right adductor and the right diductor appears to have atrophied: this indicates, according to Watson (1917, p. 215), that the brachial valve was moved laterally rather than dorsally in response to diductor contraction, although such movement must have been impossible in those oldhaminids having convex pedicle valves.

In general it is safe to assume that the oldhaminid musculature was degenerate to a degree of almost total atrophy and, although muscle fibres probably separated the epithelial layers of the mantle infold enveloping the internal plate, it is likely that the brachial structures were never elevated or slewed laterally as in normal brachiopods. This lack of movement was not detrimental to the living animal: the internal plate was elevated above the floor of the pedicle valve by the septal apparatus: a steady flow of nutrient water, circulated by the lobated lophophore, could have entered the brachial cavity by way of the distal ends of the lateral lobes and left by the median incision.

MORPHOGENY OF THE OLDHAMINID SEPTAL APPARATUS

The development of the septal apparatus in the oldhaminid pedicle valve corresponding to the lobation of the internal plate has been fully discussed by Fredericks (1925) and Wanner (1935) and needs but a brief review here.

In the primitive *Poikilosakos* a low ridge (flange of Watson, 1917), lying well within the pedicle valve margin completely surrounds the median area of the interior. The flange is roughly subcircular in outline and is indented to form a median loop only, but in adult forms the outline is more irregular, the flange being thrown into a small number of asymmetrically disposed lateral loops in addition to the median one. These loops are not greatly constricted and consequently include medianly a narrow strip of the valve floor bounded by an indented segment of the

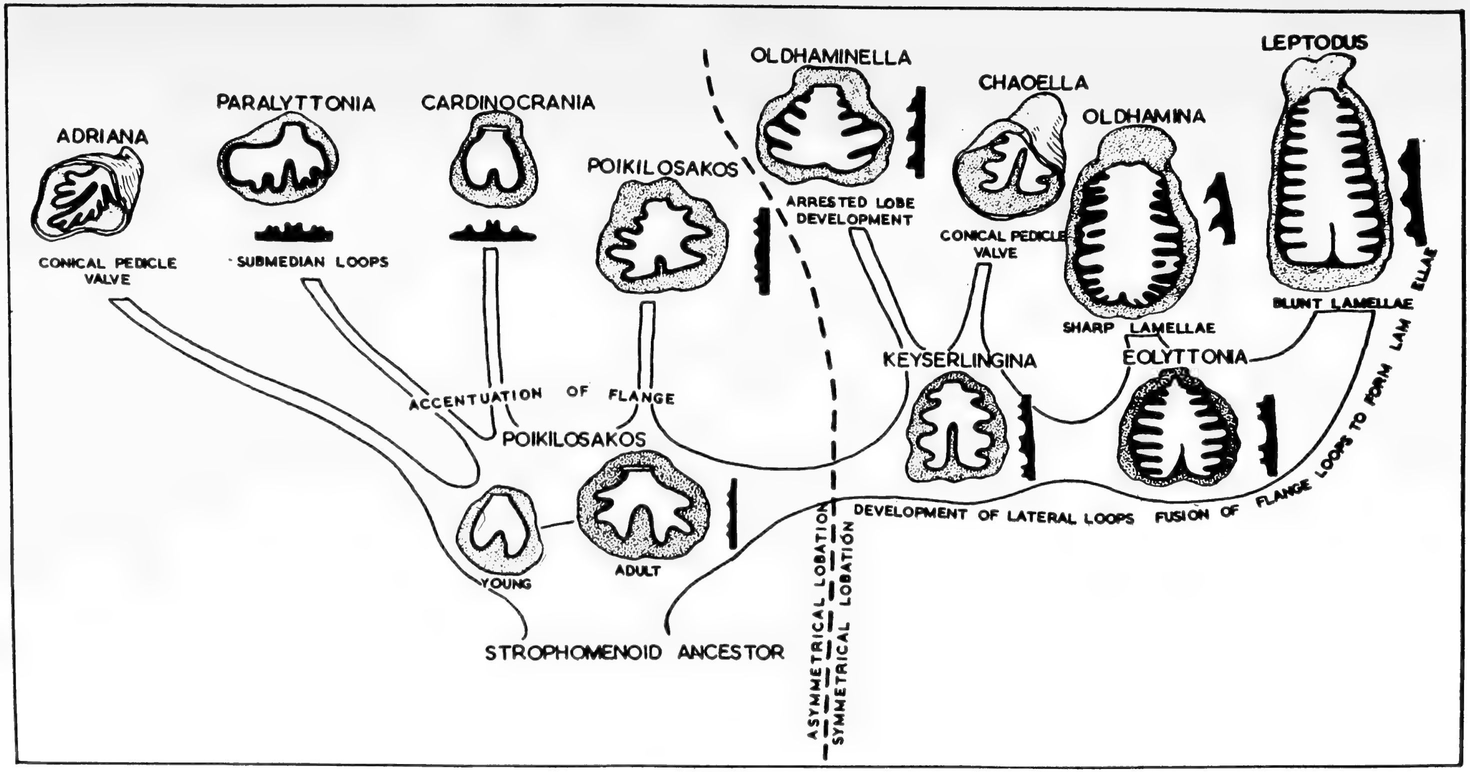

PLATE 3

Diagrammatic representation] of oldhaminoid morphogeny; the profile of a representative portion of the loop or septal development in the pedicle valve of a genus is colored black.

flange. The internal plate of the brachial valve corresponds in outline to the disposition of the flange so that it is irregularly lobate and lies so close to the pedicle valve that each lobe is seemingly isolated distally from its neighbour by a loop of the pedicle valve.

In later oldhaminids like *Keyserlingina* and *Paralyttonia* the loops begin to close by an increase in the size of the flange boundaries and their encroachment onto the median strip of the valve floor until in extreme forms like *Oldhamina* and *Leptodus* the flange boundaries to each loop are completely united into one solid septal structure. In this manner the looped flange of the earlier and more generalized oldhaminids is transformed into a series of variously fashioned septa constituting the septal apparatus of more specialized stocks.

These views on the evolution of the septal apparatus are generally accepted but there seems to be disagreement on the systematic value of the modifications resulting from loop and septal morphogeny (see Wanner, 1935, pp. 265 et seq.) which appear to have been gradually introduced during the ontogeny of the various stocks as well as phylogenetically. Thus in one specimen of *Leptodus* from the Permian of Texas the high sharp septa of the earlier formed posterior region of the septal apparatus are replaced by lower, weaker septa in the later stages of growth, and the initially undifferentiated interseptal strips of the valve floor become elevated into low broad ridges in the anterior part of the shell. These changes were first introduced at the distal ends of the earlier formed septa and gradually encroached anteriorly on to the median line as the animal grew, in such a way that the changeover, which is quite sharply demarcated, occurred along a front convex to the anterior and roughly concentric with the growing edge of the valve.

Other modifications usually associated with the evolution of the septal apparatus included an increase in the number of septa and a closing up of the median incision of the internal plate; but the most important appears to have been a reorganisation of the disposition of loops and septa so that during Permian times two main stocks existed—one characterized by asymmetry the other by symmetry in the development of loops and septa.

OLDHAMINID CLASSIFICATION

The placing of the oldhaminids within the framework of the existing brachiopod classification has been a matter of considerable speculation. Fredericks (1925) considered the group to be derived from the productid *Marginifera*, but more accurate comparative morphology has caused the rejection of this belief. Other paleontologists including Waagen and Wanner have been impressed by the apparent similarity (especially in lobated nature of the lophophore support) between the oldhaminids and the thecideids, and have considered them to be related groups. Both Watson and Noetling, however, have attributed the superficial likenesses to convergence and thus have regarded the stocks to be entirely independent, an opinion supported by the writer.

The various opinions expressed on the affinities of the oldhaminids is a reflection of the profound morphological differences separating them from all other brachiopods, and while most paleontologists place them within the strophomenoids no cogent reason has yet been put forward for allocating them either to the Strophomenoidea or to the Productoidea. That they are strophomenoids is left in little doubt when reference is made to the pseudopunctate shell, the absence of a functional pedicle and the presence of a bilobed cardinal process. But it is impossible to recognise in any of the Upper Carboniferous productoids and orthotetaceids any one stock displaying the characteristic oldhaminid features apart from the ordinal characters listed above. In view of these fundamental differences and the consequent unique nature of the oldhaminid morphology it is proposed to erect a new suborder Oldhaminoidea to embrace *Oldhamina* and its associates.

The oldhaminoids include a wide variety of forms (Pl. 3) but appear to be divisible, as a result of a basic and early divergence, into two distinct suprageneric groups dependent upon the disposition of the septa and loops and it is proposed to recognise these differences by the erection of a new family, Poikilosakidae, in the manner described below.

OLDHAMINOIDEA, n. suborder

Pseudopunctate brachiopods without a functional pedicle, usually cemented throughout ontogeny, shell surface without radial ornament, shape often highly irregular. Brachial valve vestigial occupying a small posterior triangular area of a large plate of fibrous calcite presumed to have been deposited by an infold of the mantle and to have given support to a ptycholophous or more usually a schizolophous lophophore. Pedicle valve extending posteriorly as an enormous flap intimately connected with the pedicle valve apically and posterolaterally and invariably retroflexed along a narrow median zone lying immediately dorso-posteriorly to the brachial valve, posterior flap highly variable in form, usually the principal organ of fixation and moulded to the base affording anchorage, less frequently strongly retroflexed to come in contact with the external surface of the apical part of the pedicle valve or growing anteriorly and ankylosed to the sides of the pedicle valve to form with it a deep cone. In early stocks the median area of the pedicle valve interior surrounded by a low ridgelike flange indented to form a median loop and a variable number of lateral loops; in later stocks the sides of loops coalesced to form solid septa; internal plate of brachial valve lobated to correspond to the loops or septa. Upper Carboniferous to Permian.

Family Oldhaminidae Schuchert and LeVene, 1929

Oldhaminoids with the loops or septa and hence the lobation of the brachial internal plate symmetrically disposed about the median line. Upper Carboniferous to Permian. Type genus *Oldhamina* Waagen.

Poikilosakidae, n. fam.

Oldhaminoids with the loops or septa and corresponding lobes of the brachial internal plate developed in an irregular fashion. Upper Carboniferous to Permian. Type genus *Poikilosakos* Watson.

BIBLIOGRAPHY

Fredericks, G. *New Lyttoniinae from Upper Palaeozoicum of the Oural.* Bull. Soc. Oural Amis Sci. Nat. **11** (1). 1926.

Licharew, B. *Fauna of the Permian deposits of northern Caucasus: Brachiopoda family Lyttoniidae Waagen.* Trans. United Geol. and Prosp. Serv. U.S.S.R. **215.** 1932.

Noetling, F. *Untersuchungen über die Familie Lyttoniidae Waag.* Palaeontographica **51**: 129–153. 1905.

Waagen, W. *Salt-range fossils: Productus limestone fossils.* Palaeont. Indica, ser. 13, **1.** 1887.

Wanner, J., and Sieverts, H. *Zur kenntnis der permischen Brachiopoden von Timor: 1. Lyttoniidae und ihre biologische und Stammesgeschichtlich Bedeutung.* Neues Jahr. für Min. **74:** 201–281. 1935.

Watson, D. M. S. Poikilosakos, *a remarkable new genus of brachiopods from the Upper Coal Measures of Texas.* Geol. Mag. **54:** 212–219. 1917.

ENTOMOLOGY.—*Additional material on the phylogeny and dispersal of* Atopsyche (*Trichoptera: Rhyacophilidae*).[1] Herbert H. Ross, Illinois Natural History Survey, Urbana, Ill.

The intermingling of elements of South American and North American biotas across the Central American region is a study full of fascination. The fossil record for any terrestrial group in this critical area is very scanty, so that pertinent evidence from biogeography may be our best source of information on certain phases of the subject for some time to come.

Since Dr. King and I prepared our first paper on the dispersal pattern of the genus *Atopsyche*, known only from this area, I have been fortunate in obtaining several additional lots of material and in being able to study the type of *A. implexa* (Navas). Although the new material adds only eight species to the 21 previously analyzed, it brings out several points of biogeographic interest. These fit well the concepts and postulates set forth in the earlier paper on the genus (Ross and King, 1952, Ann. Ent. Soc. Amer. **45:** 177–204) extending some ideas and suggesting modifications of others.

In the first place, the new species *ulmeri* from Peru is a close relative of *cira* from Costa Rica and demonstrates a spread of this otherwise northern group from Central America into South America. This was probably a post mid-Pliocene dispersal.

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[1] This study was aided by a grant from the John Simon Guggenheim Memorial Foundation.

It was originally suggested that at this time two South American lines spread into North America, and we wondered why we had no evidence of a complementary spread of a North American form into South America. Here it is.

Two items concern the *ikonnikovi* complex, here renamed the *kingi* complex. We thought this complex originated in South America in the Miocene, but had no really primitive South American species as evidence. The new species *kingi* from Peru proves to be such a primitive member. In addition, a new subgroup of the *kingi* complex has been discovered, typified by a pair of curious, setose, oval bodies on the third and fourth tergites of the males, fig. 5*C*. This subgroup contains three known species—a primitive one, *vatucra*, from Peru; a more specialized species, *banksi*, from Colombia; and the hitherto misplaced species *implexa* from Costa Rica. This distribution pattern complements that of the *kingi*, *dampfi*, and *boneti* triad.

A fourth point is the finding of a very primitive member of the *batesi* group in Peru, the new species *alconura*. It was postulated on phylogenetic evidence that this line originated from South American ancestors, although the known members came from Mexico and the West Indies. The discovery of a primitive form, *alconura*, in Peru suggests that the progenitor of the group may have differentiated in South America before dispersing to other areas.

The other two new species involve no controversial points. *A. explanata* from Peru is a close relative of *kamesa*, from Bolivia. *A. serica* from Brazil is the most primitive member yet known of the *longipennis* group, and emphasizes the relationship between the different lines within the group.

Unless otherwise stated, types of the new species are deposited in the collection of the Illinois Natural History Survey.

Subgenus **Atopsyche** Banks

The opportunity to study the type male of *Ventrarma implexa* Navas, the genotype of *Ventrarma* Navas, shows that it is a member of the typical subgenus *Atopsyche* and not a member of the group considered as the distinctive subgenus *Ventrarma* by Ross and King, 1952. *Ventrarma* must therefore be placed as a synonym of the subgenus *Atopsyche*. A new name, *Atopsaura*, is proposed later in this paper for the other segregate.

Atopsyche ulmeri, n. sp.

Male.—Length 5.5 mm, front wing 5 mm. Color light brownish yellow with darker areas on the mouthparts, front legs, and thorax; wings variegated with irregular light and medium spots of brown. General structure typical for genus. Abdomen with third tergite bearing a faint basal band of minute setae, fifth sternite with a small dorsal projection near base of segment. Male genitalia as in Fig. 1. Paracercus elongate with a high sharp point in middle, apical portion elongate, narrow, and curved sharply laterad at apex. Filicercus short, with a few setae at or near tip. Clasper very elongate and slender, with apical segment short, hooked at apex, with the ventral margin rounded. Aedeagus short and broad, with a narrow lateral flange.

Holotype.—Male, Paucartambo, Ccosnipata Valley, Cusco, Peru, November 15, 1951, Felix Woytkowski. *Paratypes.*—Same data, but November 26, 1951, 3♂.

This species is most closely related to *cira* (Mosely), differing in the slender apex of the paracercus and the undivided apex of the aedeagus.

Atopsyche explanata, n. sp.

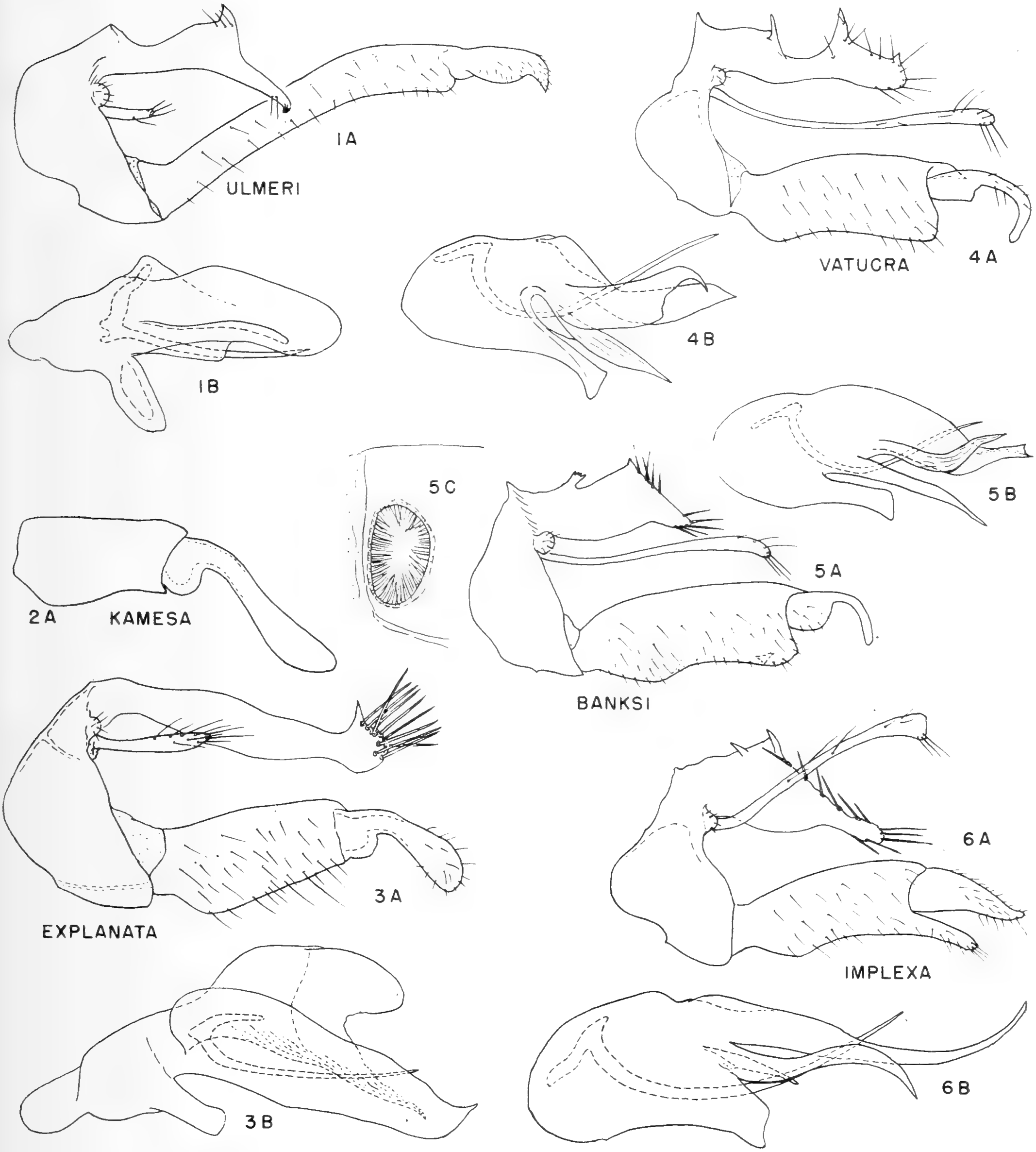
Male.—Length 7.5 mm, front wing, 7 mm. Color yellowish brown below, darker brown above, the wings a light shade of chocolate brown. Abdomen simple, without setal bands on segment three and with only a small process on the fifth sternite. Male genitalia as in Fig. 3. Paracercus slender and elongate, apparently with only the apical point, and bearing at the apex a cluster of long, stout setae. Filicercus of moderate length, with an irregular scattering of setae on the apical half. Clasper with basal segment twice as long as wide, apical segment slightly more than half length of basal one, curved and constricted in middle so as to form a clavate apex and a bulbous base. Aedeagus with a large, high, bilobed central portion, and produced on each side of this into a wide, upcurved flange. In repose the paracercus fits between the flange and the central high portion of the aedeagus.

Holotype.—Male, Paucartambo, Ccosnipata Valley, Cusco, Peru, November 17, 1951, Felix Woytkowski.

This species is a close relative of *kamesa* Ross and King, differing in the shorter apical segment of the clasper and the shallower lateral flange of the aedeagus. The true division between the two segments of the clasper is sometimes difficult to see and in the original description of *kamesa* was not truly shown. A corrected drawing of the clasper of *kamesa* is included here for reference, Fig. 2*A*.

Atopsyche kingi, n. sp.

Male.—Size and color almost identical with the preceding except that the color is slightly darker and the tibiae and tarsae are covered with brownish hair. Abdomen with third tergite bearing an irregular, somewhat oval, corner patch of minute hairs on anterolateral angle;



Figs. 1–6.—Male genitalia and associated structures of *Atopsyche*: *A*, Genital capsule, lateral aspect; *B*, aedeagus, lateral aspect; *C*, oval body on fourth abdominal tergite.

this same corner of the segment on the third and fourth tergites is produced into a short internal sclerotized band ending in a broader, rounded apex, Fig. 7*F*. Fifth sternite with only a short process. Genitalia as in Fig. 7. Paracercus with a high middle projection and a lower point at apex. Filicercus elongate and clavate. Clasper with basal segment moderately long and stout, with a somewhat angulate mesal shoulder near middle; apical segment short, broad, and curved ventrad at tip. Aedeagus with apical portion divided into two pairs of processes, the ventral pair shorter and dark, the dorsal pair longer and asymmetrical.

Holotype.—Male, Paucartambo, Ccosnipata Valley, Cusco, Peru, November 27, 1951, Felix Woytkowski. *Paratypes.*—Same data, including dates November 20, 26, and 27, 17♂.

This species is a primitive member of the *kingi* complex differing from the other members of the complex in lacking the basal tooth on the paracercus and from other species of the genus in the elongate pair of processes on the aedeagus.

The internal straplike appendage at the base of the third and fourth tergites is a most useful character in this complex. It occurs in all the members of the *kingi* complex which are available for study. In these complexes also the internal rod appears to have moved from the ventral end of the basal angulation to the dorsal end, and the apex of the aedeagus is divided into several foliatious lobes. These are at variance with the available description of *ikonnikovi*, in which the internal rod of the aedeagus is illustrated as being attached at the ventral end of its basal angulation, and the apex of the aedeagus is simple as in the *bolivari* complex. For this reason the exact placement of *ikonnikovi* is open to question. If it is indeed related to *kingi* and its relatives, then *ikonnikovi* would seem to be a more primitive member of the same line. On the other hand the two pre-apical processes on the paracercus are most unusual in that the basal one is the larger instead of being the smaller as in members of the *kingi* complex. Until actual material is available for study, *ikonnikovi* can be placed only tentatively, and perhaps best at the base of the *kingi* line. Under these conditions it seems better to use a new complex name for the aggregation of species *boneti*, *dampfi*, *kingi* and the three following, and I am using the term *kingi* complex, naming it after the most primitive known member.

Atopsyche vatucra, n. sp.

Male.—Length 6.5 mm, front wing, 6 mm. Color identical with the preceding, being a moderately dark brown for the genus. Abdomen with tergite three and four each bearing a curious oval body, Fig. 5*C*, on the antero-lateral corner of the tergite, and also the internal spatulate strap as in Fig. 7*F*; process of fifth sternite small. Genitalia as in Fig. 4. Paracercus with three points, the middle one large and high, the basal one smaller and spur-like, the apical one small. Filicercus elongate and slightly clavate. Basal segment of clasper almost rectangular, the ventral margin slightly incised and the apico-dorsal corner slightly produced on the mesal side; apical segment with the apical portion slender, finger-like and hooked. Aedeagus with three pairs of lateral processes as shown in Fig. 4*B*.

Holotype.—Male, Paucartambo, Ccosnipata Valley, Cusco, Peru, November 26, 1951, Felix Woytkowski. *Paratypes.*—Same data, 2♂.

This and the following two species form a distinct subgroup of the *kingi* complex in which the third and fourth abdominal tergites have the odd oval bodies shown in Fig. 5*C*. Of the three, *vatucra* is the most primitive as shown by the three distinct points on the paracercus.

Atopsyche banksi, n. sp.

Male.—Length 10 mm, front wing 9.5 mm. Color fairly dark brown with the usual mottling of various colored hair on the front wings. Abdomen with structures of the third and fourth tergites and fifth sternite identical with the preceding. Genitalia as in Fig. 5. Paracercus trianguloid, the apical point not evident, the middle point small but on a high triangular crest, the basal point short and stubby, its tip divided into several minute points. Filicercus elongate and clavate. Clasper with basal segment somewhat rectangular, the ventral margin slightly incised, and bearing a short mesal pointed projection near apex and a broad shoulder near base; apical segment with basal portion round, apical portion narrow, fingerlike, and curved sharply ventrad. Aedeagus with apical portion divided into three pairs of lateral lobes shaped as shown in Fig. 5*B*.

Holotype.—Male, San Antonio, Colombia, 1,800 meters elevation, February, Fassl. coll. (Museum of Comparative Zoology).

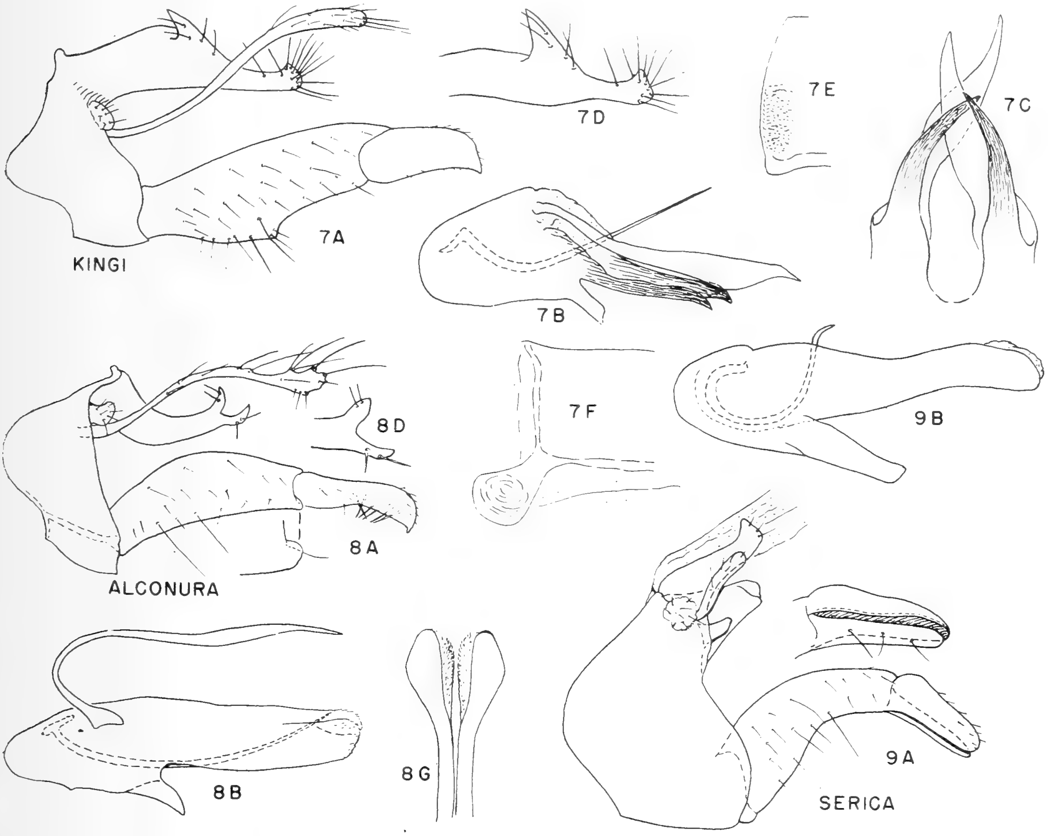
This species is a close relative of *vatucra*, the two being obviously grouped together on the basis of the odd clasper. From *vatucra*, *banksi* differs in the shape of the point on the paracercus and the lobes of the aedeagus.

Atopsyche implexa (Navas)

Thanks to the courtesy of officials of the Paris Museum, the type male of this species was studied in detail and compared with a second specimen, also labeled "Costa Rica" which was identical with the type and was made available for further study. To supplement the original description the following is added, together with illustrations of parts in Fig. 6.

Male.—Length 8 mm, front wing 7.5 mm. Structures of abdominal tergites three and four and sternite five, identical with those of the preceding two species. Male genitalia as in Fig. 6. Paracercus high and trianguloid, with no apical point but with middle and basal points spurlike. Filicercus elongate and almost clavate at apex. Clasper fairly broad, with apico-ventral corner produced into a long fingerlike projection which extends two thirds along the apical segment; apical segment almost triangular but also sinuate, tapering to a sharp point. Aedeagus with three pairs of lateral processes, the upper pair very long, the middle pair fairly long, and the ventromesal pair very short and scarcely visible from lateral view.

The resemblance of the clasper to that of *majada* is quite striking, and on this evidence alone the species was originally considered a possible close relative of *majada*. Details of abdominal tergites three and four, of the various structures of the aedeagus, and the paracercus, however, demonstrate clearly that this species is not at all close to *majada* but instead belongs in the *kingi* complex.



FIGS. 7–9.—Male genitalia and associated structures of *Atopsyche*: *A*, Genital capsule, lateral aspect; *B*, aedeagus, lateral aspect; *C*, apex of aedeagus, ventral aspect; *D*, apical portion of paracercus. ventrolateral aspect; *E*, anteroventral corner patch on fourth abdominal tergite; *F*, inner view of opposite anterior corner showing spatulate process; *G*, apex of aedeagus, dorsal aspect.

To date this species is known only from the type, bearing the data "La Caja, Costa Rica, Paul Serre 1920," and specimen here studied, labeled "Costa Rica."

Atopsyche dampfi Ross and King

Previously known only from Mexico, a record for another country may be added: Rosario Mines, Honduras, April 30, M. Bates, 1 male. (Museum of Comparative Zoology)

Subgenus **Atopsaura,** n. subgen.

As explained earlier, the genotype of *Ventrarma* actually does not apply to the group which was called the subgenus *Ventrarma* by Ross and King. For this latter segregate I am proposing the name *Atopsaura*. The genotype is hereby designated as *Atopsyche hamata* Ross and King.

Atopsyche alconura, n. sp.

Male.—Length 6.5 mm, front wing 6 mm. Color fairly light brown, intermediate between the yellowish brown of *ulmeri* and the darker brown of the other species. Abdomen with tergite three having a very faint basal band of minute hairs, and with process of fifth sternite small. Genitalia as in Fig. 8. Paracercus elongate and curved dorsad, the apex divided into two sharp processes, with no projections basad of these. Filicercus elongate; its apex is almost capitate, and is irregular due to the wartiness of the bases of the setae. Clasper with basal segment somewhat bowed, its apico-ventral corner slightly produced into a rounded extension overlapping the corner of the apical segment, apical segment moderately slender, largest in middle, the extreme apex produced into a short ventral point, and the mesal margin armed with several long sharp setae. Aedeagus simple, except for the dorsal spine typical of the *batesi* group.

Holotype.—Male, Paucartambo, Ccosnipata Valley, Cusco, Peru, November 26, 1951, Felix Woytkowski. *Paratype.*—Same data, 1♂; Cangallo, south Peru, 2,600 meters elevation, 1♂ (Hamburg Museum).

Judged by the short apicoventral process of the basal segment of the clasper, this species seems to be the most primitive known member of the *batesi* group. It is readily distinguished from the other members by this character and by the curious bifurcate tip of the paracercus.

Atopsyche serica, n. sp.

Male.—Length 8.5 mm, front wing 8 mm. Color dark brown with the usual mottling. Abdomen without special structures on the third and fourth tergites and with only a small process on the fifth sternite. Genitalia as in Fig. 9. Paracercus very short, directed more dorsad than posteriad, and with neither middle nor basal point. Filicercus slightly shorter, fingerlike. Ventrad and mesad of these two structures is a short thumblike projection. Between the filicerci and below the tenth tergite is a curious horseshoe-shaped structure beneath which the aedeagus protrudes. In lateral view this appears as an inconspicuous hoodlike structure between the paracerci. Basal segment of clasper bowed and directed more dorsad than usual; its ventral mesal margin is apparently produced into a long, narrow flange which extends along the inner side of the apical segment, which is grooved to receive it; apical segment elongate, oval, widest near base, and rounded at apex. Aedeagus very simple, the internal rod coiled as in *longipennis*.

Holotype.—Male, Nova Teutonia, Brazil (27°11′ B, 52°23′ L) October 4, 1939, Fritz Plaumann (Museum of Comparative Zoology).

This species is closest to *longipennis* but the claspers are a little more suggestive of *hamata*. It is distinguished from all other members of the group by the extra pair of short lateral processes below the filicercus and the sclerotization of the structure above the opening for the aedeagus.

This species emphasizes the unusually rapid rate of morphological differentiation which has occurred between species of the *longipennis* group in contrast with the species of other groups in the genus. It is also interesting to note that in this species unusual pairs of processes have been added which are reminiscent in both position and appearance of structures in some of the Australian and New Zealand genera which are only distantly related to *Atopsyche*. This demonstrates the tendency toward the parallel development of similar genitalic structures in the tribe.

Atopsyche falina Ross and King

An additional record has been received from Argentina, the only country for which this species is known: El Tuncho Catanarca, Argentina, 2500 meters elevation, May 5, Jorgansen, 2♂ (Museum of Comparative Zoology).

Atopsyche mexicana (Banks), n. comb.

Philopotamus mexicanus Banks, Trans. Amer. Ent. Soc. **27**: 370. 1901.

The type, in the Museum of Comparative Zoology, was examined in 1951 and found to be without abdomen, so that it is not possible at present to identify the specimen beyond genus. The venation indicates definitely that it belongs to *Atopsyche.*

Atopsyche callosa (Navas)

I had an opportunity to study the type in the Paris Museum. Although labeled and recorded in the original description as a male, the specimen actually is a female, and could not be identified except to genus.

ORNITHOLOGY.—*Feeding adaptations and systematics in the avian order Piciformes.* William J. Beecher, Chicago Natural History Museum. (Communicated by Herbert Friedmann.)

Recently Dr. Herbert Friedmann offered for my study some spirit specimens of honeyguides (Indicatoridae), together with other members of the order Piciformes. It was hoped that such an investigation as I carried out for the Neotropical honeycreepers (Beecher, 1952) might cast further light on both the feeding adaptation and systematic position of these birds so well studied by Friedmann (in MS.). Checking the systematic position of the honeyguides required a somewhat hasty completion of a long-time survey of jaw musculature in the class Aves which I will publish elsewhere. The present paper simply deals with the food adaptations in the head region of the piciform honeyguides, barbets, puffbirds, jacamars, toucans, and woodpeckers, which seem to occupy an interesting position between the perching birds (Passeriformes) and the remaining avian orders. Specimens used are from the collections of the United States National Museum and Chicago Natural History Museum. For their use or for advice, I am indebted to Herbert Friedmann, Austin L. Rand, Emmet R. Blake, and D. Dwight Davis.

SPECIMENS EXAMINED

Although a limited number of anatomical specimens was studied, the use of numerous skulls of related species considerably swells the list of material examined. This material is sufficient to suggest very strongly that the same constancy of muscle pattern found to hold for the species of passerine families holds for non-passerine families as well. Species dissected are: (Indicatoridae) *Indicator minor conirostris, I. exilis, I. maculatus, I. minor minor;* (Ramphastidae) *Pteroglossus torquatus, Ramphastos cuvieri, Selenidera spectabilis;* (Capitonidae) *Lybius leucocephalus, Megalaema haemacephala, M. rafflesii, M. zeylanica, Trachyphonus purpuratus;* (Bucconidae) *Chelidoptera tenebrosa;* (Picidae) *Colaptes auratus, Dryocopus pubescens, Melanerpes carolinus, M. erythrocephalus, Piculus chrysochloros, Picumnus squamulatus.* No specimens of jacamars were on hand to dissect, unfortunately, but skulls strongly suggest their close alliance with the barbets.

INVESTIGATION TECHNIQUES

In undertaking this study I have pursued essentially the plan laid out in my paper mentioned above and in the more comprehensive work on the phylogeny of the Oscines (Beecher, 1953). This consists in comparing various systems throughout the groups considered, as illustrated in the figures for the families. In each of these the jaw musculature is illustrated in side view and oblique view (with eye removed), as indicated in black on the accompanying skull drawings. The tongue is drawn on the right above and the ectethmoid plate with its foramina (separating the orbital and nasal cavities), on the left. In the center is figured the horny palate pattern and the bill. The logic behind the comparison of systems is that it should be possible in an avian order to establish a ground plan from which the groups (families) are adaptively specialized. Special emphasis was placed on jaw muscle pattern as a family trait in the Oscines because song-bird families appear to be diverging from such a ground plan under the selection pressure of different food types and because each family tends to have a very constant pattern. In the present order the muscle patterns seem to exhibit conservative differences between the families that prove ideal both for emphasizing their adaptive differences and at the same time encompassing them within the diagnosable ground plan of Piciformes. The other characters illustrated serve to safeguard against erroneously including a convergent species, occasionally possible if a single character is used blindly—and to further point up functional differences between the families in these less conservative parts. These systems will now be taken up below to see how well they support the current ornithological opinion that the piciform families are closely related and to show the extent to which they are differently adapted for food-getting.

THE JAW MUSCLE PATTERNS

No systematic account of muscle origins or insertions will be included here. This is well covered in Moller (1931) and Fiedler (1951); the abbreviated account in Beecher (1951b) should suffice for the understanding of muscle function stressed in the present paper since the same muscles are concerned.

A strong facies resemblance between the jaw muscle patterns of the piciform families persists through their quite different food adaptations, which constitutes one of the best arguments for close relationship. The far posterior position of the flattened pterygoid bones where they articulate with the palatines along the sphenoidal rostrum causes *M. pterygoideus dorsalis posterior* (*M3b* in Figs. 1 and 2) to be nearly obscured from view, suggesting relationship with Trogoniformes and Coraciiformes. *M. pterygoideus dorsalis anterior* (*M3a*) is correspondingly enlarged to make up the needed power for retracting the pterygoids, its broad insertion on the sphenoidal clasp, formed by the articulation of the palatines and pterygoids, covering *M. pterygoideus ventralis posterior* (*M4b*). The functional result is unusual emphasis on palate retraction in the kinetic bills of all of these families. Since this retraction is translated by the nasofrontal hinge into a downward drag on the upper mandible, the unusually heavy construction of this part is clearly functional in feeding. Along with this is a considerable emphasis on the adductors. In Capitonidae and Ramphastidae *M. pseudotemporalis profundus* (*M5*) is powerfully developed for dragging on the orbital process of the quadrate and rocking this important bone backward on its articulation with the cranial part of the skull, initiating palate retraction and adduction of the upper mandible.

This emphasis on the palatine retractors and the adductors is about proportional to the mass of the bill in the several families studied. In Capitonidae, and particularly in *Lybius* with its stout, notched bill, *M. pterygoideus ventralis posterior* (*M4b*) originates all along the outer surface of the mandibular ramus posteriorly, as well as on the customary inner surface. This is also noted in Ramphastidae and Picidae in progressively lesser degree (the former with *M4a* and *b* fused) but not in Indicatoridae. The adductors are also most strongly stressed in the Capitonidae and Ramphastidae, the temporal slip of *M. adductor mandibulae externus superficialis* (*M7a*), particularly, showing a deep incursion to the dorsal midline of the skull posteriorly. This is not met with in the Oscines but is characteristic of the Suboscines and a vast majority of other avian orders.

The Picidae have a good expression of both palatine retractors and adductors but are outstanding for the extreme emphasis on the protractors of the mandibles, *M. depressor mandibulae* (*M1*) and *M. protractor quadrati* (*M2*). This is especially so in the latter, which originates over most of the area of the interorbital septum which (unlike most birds) is thoroughly ossified in woodpeckers to protect the brain and unusually ossified in the other piciform families. This arrangement, which is met in the piculets as well as in the more highly-adapted woodpeckers, is also found among passerines in the nuthatch *Sitta*. Its effectiveness in prying is evident, and it is seen (with *M2* less well expressed) in numerous species of prying birds (Beecher, 1950; 1951a and b); but in woodpeckers it probably serves as part of an interesting shock absorbing mechanism. I disagree with Burt (1930) that the woodpecker bill is immovably joined to the skull in even the most highly adapted forms. The only unkinetic bird skull is seen in the lizard-like subclass Archaeornithes. In all other birds the upper mandible joins the skull at the naso-frontal hinge and the jugal-palatopterygoid armature joins its base to the quadrate in a frame that slides along the sphenoidal rostrum under the control of the jaw musculature. The key bone in this process is the movable quadrate which permits these antero-posterior movements of the armature to be translated into elevating and depressing movements of the upper mandible

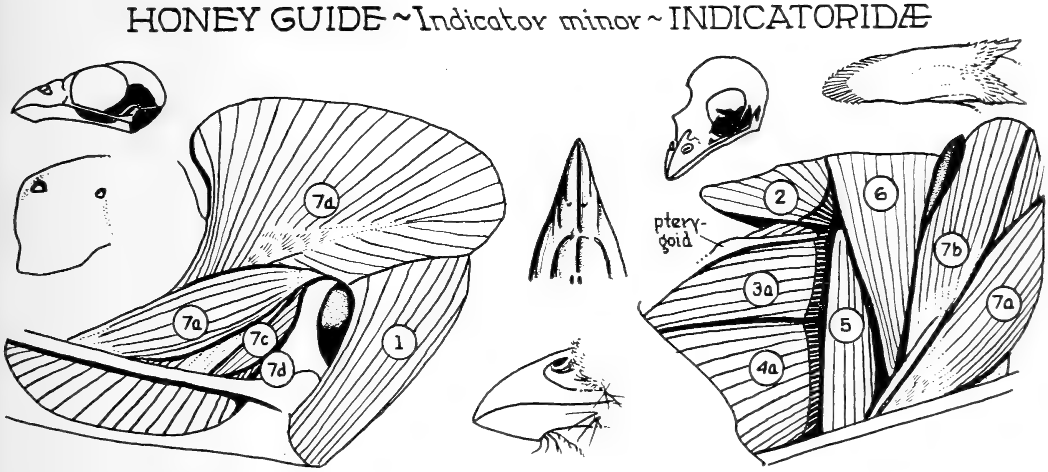


FIG. 1.—Detail drawing of jaw muscle pattern of the honeyguide (Indicatoridae).
Protractors. 1 depresses the lower mandible; 2 elevates the upper mandible.
1. *M. depressor mandibulae*
2. *M. protractor quadrati*

Palatine retractors. Combined action draws upper mandible downward.
3. *M. pterygoideus dorsalis:* a) *anterior;* b) *posterior* (underlies 2)
4. *M. pterygoideus ventralis:* a) *anterior;* b) *posterior* (underlies a)
5. *M. pseudotemporalis profundus*

Mandibular adductors. Combined action draws lower mandible upward.
6. *M. pseudotemporalis superficialis*
7. *M. adductor mandibulae:* a) *externus superficialis;* b) *externus medialis;* c) *externus profundus;* d) *posterior*

In the shock-absorbing mechanism of woodpeckers and nuthatches the antagonistic action of the enormous *M2* against the retraction of the pterygoid musculature probably holds the bill in a state of resilient rigidity as it rains its blows on a tree trunk. Woodpeckers also have a special nasal mucous gland (Technau, 1936); this is visible in the floor of the orbit just ventral to the ectethmoid plate and is less well expressed in sapsuckers (*Sphyrapicus*) than other genera. Since this may serve to trap dust raised by pecking (an occupational hazard of woodpeckers like silicosis among humans!) sapsuckers, habitually working soft, green wood, may not need it so much. This has nothing to do with the enormous sub-lingual mucous gland which serves to make the woodpecker tongue sticky.

The Indicatoridae, strange to say, show no specializations of the jaw musculature or salivary glands at all. The bill, too, is more generalized than that possessed by any other piciform family, except for the unusual feature that the tips of the peculiarly blunted mandibles meet without notable overlap of the upper—an adaptation, possibly, for biting off bits of wax and honey. But the general facies of the order is recognizable in the jaw muscle pattern which is more generalized than in any of the other families. This is clearly seen in the simple *M. pseudotemporalis superficialis* (*M6*) which, in the other families, shows a slight approach to the Suboscines and to Coraciiformes and possibly Trogoniformes. The honey-guide musculature is, in fact, the nearest seen in any of these families to the ideal ground plan for the order. This is not to state that this family is actually ancestral to the others but only that it may more nearly resemble the less specialized common ancestor. In other respects I am inclined to think the basic stock might have been more like the barbets but these have now, in process of developing a massive musculature for power, sheathed much of the musculature in tough aponeuroses to which shorter fibers fuse in semblance to the pinnate muscles so important in the higher Oscines. This is an arrangement found in primitive oscinine shrikes like Cracticidae, Prionopidae and Vangidae. The only muscles that could class as pinnate in Piciformes are the temporal slip of *M7a* and *M7c*. This supports the general opinion as expressed in Wetmore (1940; 1952) and in Mayr and Amadon (1951) that the group is somewhat more primitive than Passeriformes.

THE TONGUE

The tongue is not generally a very reliable index of relationship in birds (Beecher, 1951a) because it is apparently so readily modified in conjunction with an extreme feeding adaptation. This is true in Piciformes. The tongues of barbets are the generalized tongues of insect eaters, not distinguishable by any reliable characters from those of some passerine insect eaters, except that, like the other piciform families, the papillae of the posterior surface of the tongue are unusually abundant. The moderately frayed out horny tip is unspecialized in barbets and the tongues of honey eaters are very similar. The tongues of the toucans are simply elongate and narrow, with the fringe extending well posterior; such a tongue would be useful in lapping juice from pulpy fruits as well as in the usual process of biting out pieces. The woodpecker tongue is so vastly modified from the ground plan of the order that little external evidence of relationship remains here. The frayed horny fringe is directed backward as a battery of barbs and the papillae of the posterior border are directed inward to permit withdrawal of the tongue within a skin sheath. The long hyoids of woodpeckers and the great extensibility of the tongue need no special description.

HORNY PALATE

The horny palate is in large measure dependent on the tongue and does not always provide direct evidence of relationship where adaptive re-arrangement has been extensive, as in the Picidae. In the other four families dissected there is a notable resemblance in the thin cutting edge of the tomium in the upper mandible, combined with the vaulting of the palate itself. This is so pronounced that little evidence of a lateral palate ridge, generally present in passerines, can be seen. The central ridge is strong in all families. Posterior palate relief is rather non-descript.

ECTETHMOID PLATE

The ectethmoid plate is convincingly similar in all of the piciform families and all have the foramen double. This condition is considered advanced in my work on the Oscines, primitive forms having a single foramen which is larger the more primitive they are. In Galliformes, a possible ancestor, the foramen may be said to occupy the entire plate which is not closed ventrally at all.

THE BILL

The bill is similar in ground plan in all but the woodpeckers and jacamars, with a very strongly bowed culmen and rather massive upper mandible. The nostril is far posterior, non-operculate and (in honeyguides) raised into a membranous tube. In barbets the bill may be long or short with the tomium sometimes notched as in *Lybius*, a feature that seems to be multiplied with length in the toucan bill. Barbets have abundant narial and chin bristles as do puffbirds, but the elongate, straightened bill of jacamars shows reduction of bristles. Puffbirds generally have narrowed, hooked bills. Toucans, woodpeckers, and honeyguides have the bristles virtually lacking and the bills without hooks, except for a slight tendency in toucans which are also much notched. The toucan bill is, of course, unique in the degree of lightness achieved with its cancellous internal structure.

In connection with the bill the barbets seem to be fruit and insect eaters, often expert flycatchers; puffbirds are lethargic flycatchers; jacamars, graceful and swift flycatchers. Toucans are fruit and insect eaters. Woodpeckers are specialized insect eaters, eating many wood-boring insects, but also anteaters and flycatchers, some taking sap and flower juices as well as fruit. Honeyguides are insect eaters that evidently have become specialized for eating honey and even getting nutrition out of beeswax. This adaptation will be discussed further.

PLUMAGE

Barbets generally have brilliant plumage—barring and streaking on a ground of yellow or green with flashmarks of crimson—which is clearly similar to that of some woodpeckers. Puffbirds, with barred and streaked plumage also, are duller in color and jacamars are more often coppery green and iridescent brown in solid masses. The puffbirds *Nystalis* and *Malacoptila* (and the woodpecker, *Jynx*) resemble owls and nightjars in plumage, the jacamars resemble hummingbirds. This resemblance is not taken as evidence of direct relationship but other lines of evidence suggest that these orders and many others may be springing independently from Galliformes which I am inclined to regard as our most primitive, unspecialized bird stock. Toucans have plumage patterns of solid greens and yellows and reds suggestive of barbets. Honeyguides re-

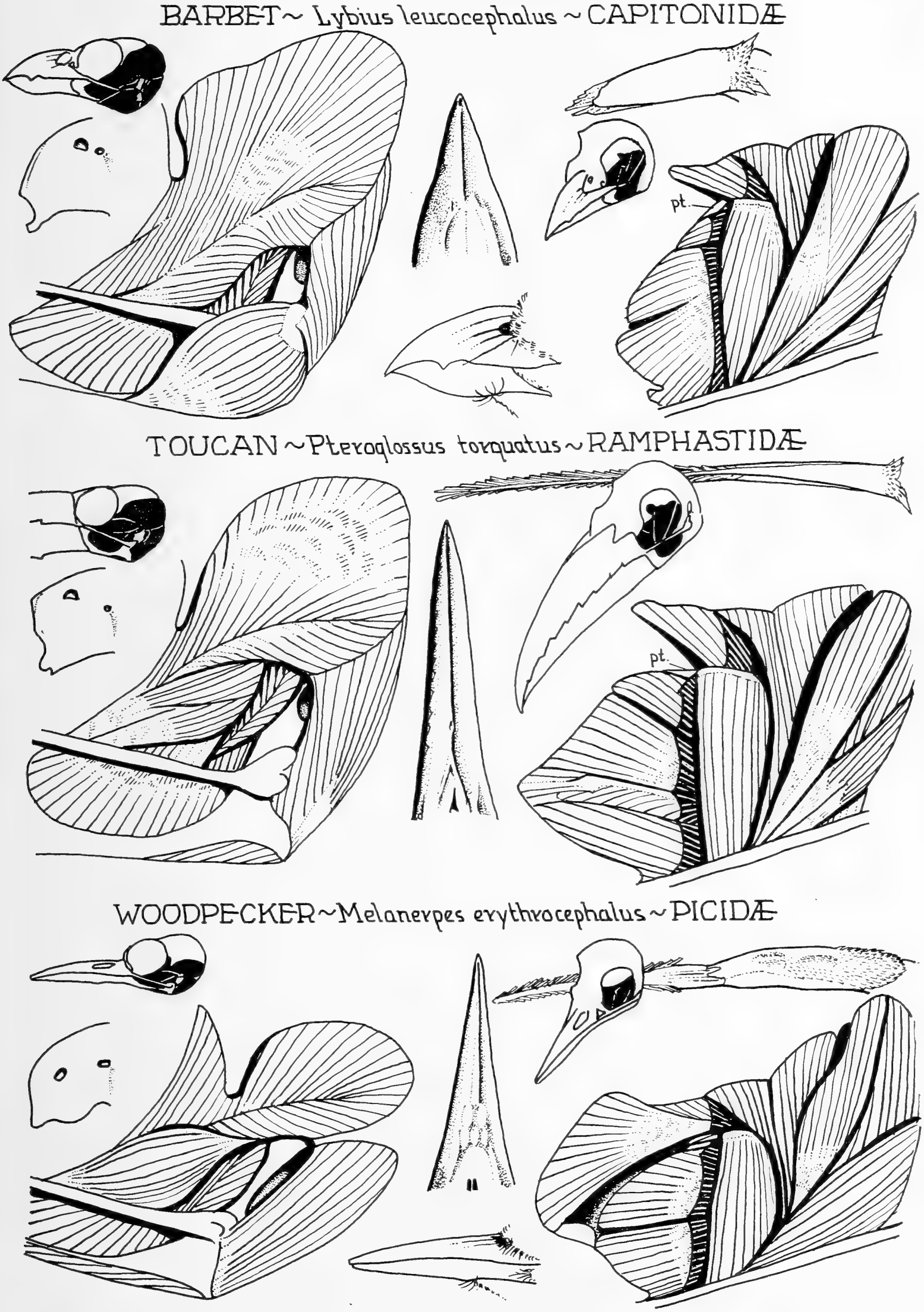


Fig. 2.—Detail drawing of jaw muscle pattern in the barbet (Capitonidae), toucan (Ramphastidae), and woodpecker (Picidae).

semble certain dull-patterned barbets like *Lybius leucocephalus*. On the basis of plumage, in fact, one would be inclined to say that all piciform families may have originated from the barbets. If so, it would have been before the bills became as specialized as they are now, in all probability.

OTHER CHARACTERS

The idea that the barbets may be the ancestral piciform family is supported by other characters which might be preadaptive to traits highly expressed in the other families. All these families have zygodactylous feet in which the second and third toes are directed forward, the first and fourth, backward. This arrangement of toes is particularly advantageous for birds climbing about on tree trunks as barbets and woodpeckers do or for perching. Toucans and honeyguides may have largely abandoned this trait without the toes being under any selection to return to the usual condition. Barbets have many of the woodpecking traits of Picidae with highly ossified interorbital septum, a feature found throughout the order, but especially in Picidae. Barbets excavate holes as do woodpeckers. Toucans nest in hollow trees. Honeyguides are parasitic on hole-nesting birds, often members of Piciformes, according to Bannerman (1933). In the pelvic appendage, the re-arrangement of the toes has resulted in changing the position of tendons and loss of the *ambiens* muscle, considered of important diagnostic value by Garrod (1873).

WAX-EATING IN THE HONEYGUIDES

As to the honey- and wax-eating adaptation in honey guides, no notable specialization of digestive organs was found. There is no sign of enlarged palatine salivary glands such as are found in all the nectar-eating groups of the world (Beecher, 1953)—Dicaeidae, Nectariniidae, Meliphagidae, and the New World hummingbirds and honeycreepers. If only honey were taken this would not be surprising because the bulk of this is immediately assimilable and there would be little need for invertase or any enzyme for breaking down sucrose. But Friedmann (MS.) has evidence that honeyguides are able to derive nutrition from beeswax, implying a rather complex enzyme action. With the specimens available I could carry out only the crudest sort of sampling technique aimed at studying wax digestion. I removed food material from the oral cavity, stomach, and hind gut of the species studied and heated it on a scalpel blade. A wax residue was obtained on the blade from contents so treated of oral cavity and stomach of *I. exilis* and *I. maculatus* in some samples—never from the hind gut. This might suggest wax digestion in the stomach or small intestine were the sampling adequate. As it stands these results are merely suggestive.

This trait of the honeyguides is the more interesting because of their general flair for parasitism. They lay their eggs in the nests of other birds, often close relatives, and they have learned to get animals more capable than themselves to uncover the honey combs they prefer to feed on. They must have started this specialization in habit by leading animals, perhaps the honey badger (*Mellivora*) to hives. Chapin (1939) suspects other mammals, including squirels and monkeys, of aiding the birds in getting at honey. The discovery, apparently only by *Indicator indicator*, that man could be led to bee trees with satisfactory results is necessarily a recent specialization of the trait.

SUMMARY AND CONCLUSIONS

An investigation of feeding adaptations in the head region of the piciform bird families, Capitonidae, Bucconidae, Ramphastidae, Picidae and Indicatoridae, was undertaken to study their morphological and systematic relationships. The jaw muscle pattern shows a strong facies resemblance in all, suggesting that the order Piciformes is a real unit. The honeyguides have the least specialized pattern and may represent the ground plan from which the other families have been derived, though other indications are that the barbets are nearer the ancestral stock. From this ground plan the barbets diverge by having more massive adductors and palatine retractors, the toucans by fusing the slips of *M. pterygoideus ventralis* and sheathing the musculature increasingly in aponeuroses for increased palate retraction. The woodpeckers extend enormously the origins of the mandibular protractors, particularly *M. protractor quadrati*, a powerful antagonist to the muscles of palate retraction, to produce a shock absorber for the bill. The tongue is so far modified in toucans and woodpeckers as to offer little positive evidence of relationship but the horny palate is less modified and the ectethmoid plate is similar in all. Bills and feeding habits suggest close but disjunct relationships in a single series and plumage suggests origin of piciform families from the barbets or an ancestral group with a somewhat less-pronounced bill. Zygodactylous feet and the hole-nesting habit, taken in combination with the above, support present ornithological thought as to the unity of the order. The trait of honey guides of leading animals to bee hives seems to be part of a general parasitic complex which includes brood parasitism as well. No digestive abnormalities were noted but enzymes for wax digestion may be produced in stomach or small intestine.

LITERATURE CITED

BANNERMANN, D. A. *The birds of tropical West Africa* **3:** 1–487. Edinburgh and London, 1933.

BEECHER, W. J. *Convergent evolution in the American orioles.* Wilson Bull. **62:** 51–86. 1950.

———. *Adaptations for food-getting in the American blackbirds.* Auk **68:** 411–440. 1951a.

———. *Convergence in the Coerebidae.* Wilson Bull. **63:** 274–287. 1951b.

———. *A phylogeny of the Oscines.* Auk **70:** 270–333. 1953.

BURT, W. H. *Adaptive modifications in the woodpeckers.* Univ. California Publ. Zool. **32:** 455–524. 1930.

CHAPIN, J. P. *The birds of the Belgian Congo. Part 2.* Bull. Amer. Mus. Nat. Hist. **75:** 1–632. 1939.

FIEDLER, W. *Beitrage zur Morphologie der Kiefermuskulatur der Oscines.* Zool. Jahrb. (Anat.) **7:** 235–288. 1951.

FRIEDMANN, H. *The honey-guides.* (MS.)

MAYR, E., and AMADON, D. *A classification of Recent birds.* Amer. Mus. Nov. no. 1496: 42 pp. 1951.

MOLLER, W. *Über die Schnabel- und Zungenmechanik blütenbesuchender Vogel. II.* Biol. Gen. **7:** 99–154. 1931.

TECHNAU, GERT. *Die Nasendrüse der Vögel. Zugleich ein Beitrag zur Morphologie der Nasenhöhle.* Journ. für. Orn. **84:** 511–617. 1936.

WETMORE, A. *A revised classification for the birds of the world.* Smithsonian Misc. Coll. **117:** 1–22. 1951.

ZOOLOGY.—Psammodesmus, *a neglected milliped genus* (*Polydesmida: Platyrhacidae*). RICHARD L. HOFFMAN, Clifton Forge, Va. (Communicated by H. F. Loomis.)

It is unfortunate that much of the previous work on diplopod taxonomy has been of rather poor quality. Far too often one finds himself obliged literally to revise a genus or tribe before feeling safe in placing an undescribed species. This is precisely the situation I encountered on endeavoring to place a new platyrhacid milliped found in the collections of the U. S. National Museum. Fortunately, however, the problem has been of fairly easy resolution although depending upon some rather extensive nomenclatorial changes. Although the group directly involved is a South American one, it has been necessary to consider the entire family of the Platyrhacidae. This has been made possible by the exceptionally useful treatise by Carl Attems, in Das Tierreich, Lief. 69, 1938. Despite the value of this reference, I believe that Attems's somewhat conservative treatment does not give proper recognition to the numerous species-groups whose characters seem clearly to be of generic level. Attems recognizes a single genus—divided into six subgenera—with the characters which I ascribe to the family Platyrhacidae. (The other six genera of "Platyrhacidae" treated in his monograph are referable to the family Euryuridae in the sense of Pocock and Chamberlin.)

Interestingly enough, the first contribution to the systematics of the tropical American platyrhacids, by O. F. Cook (1896), still appears to provide the most logical arrangement of the species! Cook was the first worker to break up the large widespread genus *Platyrhacus* (*Acanthodesmus* or *Stenonia* of early writers) with the proposal of numerous generic names. His arrangement, although reasonable, was never generally accepted, and the most authoritative recent workers have reverted to the use of the name *Platyrhacus* for the majority of the species. There are, however, within the family a great number of diverse types which, if they occurred in the temperate regions where faunas are better known, would long ago have been recognized as well-marked genera.

Cook's paper "New American Platyrrhacidae" (Brandtia, 1896, no. 12) included the diagnoses of nine new American genera. Four of these (*Nyssodesmus*, *Tirodesmus*, *Nanorrhacus*, and *Rhyphodesmus*) have been recognized at one time or another by American workers. Various others were accepted by Silvestri in his papers on the neotropical forms and one of these, *Psammodesmus*, becomes the subject of the present paper. The genus is redefined on the basis of gonopod structure and a new species is proposed. The type species designated by Cook has not been examined,[1] but the characters of the genus, as stated in Cook's description, seem to be quite adequate for at least a generic recognition. The specimens at hand keyed out readily to *Psammodesmus* on the basis of nonsexual characters; somewhat later it was found that in gonopod structure they are very close to the two species which Silvestri described in that genus in 1897.

APPLICATION OF THE NAME PLATYRHACUS

The primary difficulty involved in the systematics of the American species is the identity of the type species of *Platyrhacus*. Concerning this matter, Cook wrote (op. cit., p. 51):

> The genus Platyrrhacus was based by C. L. Koch on a Brazilian species, *Polydesmus scaber* Perty, or at least on a specimen so determined, and described as being slightly convex, densely granulate, and with a row of distinct, pearl-like tubercules along the posterior margin of each segment. There are said to be two other rows of somewhat smaller tubercules placed wider apart. Although the carinae are said to be strongly toothed, they appear from the plate that the teeth are broad and rounded. After studying the description in connection with that of another American species described by Koch, *Platyrrhacus rufipes*, the opinion has been gained that it would not be safe to identify it, even generically, with any of the material which has come into my hands for study.

Since no types of Koch's species have ever been found, to my knowledge, and since it was not customary in his time to designate and retain type specimens, it seems to me that some sort of arbitrary action may be needed to resolve the matter satisfactorily. About the only tangible information for a starting point is the likelihood that since Perty's original animal came from Brazil, the specimen identified as *scaber* by Koch most probably had a like provenance even though we can never be sure it was even congeneric with Perty's species.

If *Platyrhacus* as used by Attems is to be divided into more natural genera, the generic name in its restricted sense must be applied to one of the South American genera. Attems disregarded this necessity in designating *Polydesmus pfeifferae* Humbert and Saussure, 1869, an East Indian species, as type of the genus.

There is a considerable number of recognizable American genera, distinguished for the most part by the structure of the gonopods. Of these genera, *Tirodesmus* and *Aymaresmus* are disqualified, so far as application of the name *Platyrhacus* is concerned, because of the shape of the keels in those two groups. Of the remainder, it seems best to apply the name to that genus which is most numerous in species and has the widest range; and thus would be most likely encountered by early collectors. The group which most readily qualifies is that including *clathratus*, *bilineatus*, *propinquus*, *tenebrosus*, and their close relatives. It extends from Nicaragua into western Brazil. There is nothing in Koch's description and plate to preclude association of his generic name with this group (of which Cook apparently had seen no specimens—cf. the last sentence of his paragraph quoted above).

It is felt that an eventual decision regarding the identity of *P. scaber*, involving a redescription and designation of type specimens, will be desirable and necessary for a final settlement of this issue. At the present time this step can not be taken, in the lack of adequate material for study.

Should the present allocation meet with general approval, it will become necessary to select one of the numerous generic names already available for the group of Indonesian species treated by Attems in his subgenus *Platyrhacus*. Ten such names (proposed by Cook, Pocock, and Silvestri) are listed as synonyms in Attems's account. Since his "subgenus" seems clearly to be heterogeneous, it is probably advisable to delay nomenclatorial settlement until at least a partial

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[1] *Psammodesmus cos* was based on a specimen lent to Cook by the Academy of Natural Sciences of Philadelphia. Dr. J. A. G. Rehn, curator of insects at that institution, informs me that it is not now in their collection and probably was not returned. I have not been able to locate it in the National Museum collection, wherein most of Cook's material was deposited.

restudy of the East Indian forms has been made.[2]

Genus **Psammodesmus** Cook

Psammodesmus Cook, 1896, Brandtia, no. 12: 52.—Silvestri, 1897, Boll. Mus. Torino **12** (305): 15.
Platyrhacus subgenus *Tirodesmus* Attems, 1938, Das Tierreich, Lief. **69**: 229 (in part).
Ernostyx Chamberlin, 1941, Bull. Amer. Mus. Nat. Hist. **78**: 497 (type, *E. moyobambus* Chamberlin).

Type species.—Psammodesmus cos Cook, by original designation.

Generic diagnosis.—Platyrhacid millipeds characterized by the following combination of features: Dorsum slightly arched, keels set high on sides; lateral edges of keels almost smooth, bearing only two or three small teeth (somewhat emarginate in *moyobambus*); tergites divided into three transverse rows of poorly defined polygonal areas, each of which has a tiny median tubercule; repugnatorial pores small, removed from the edge of the keels by a distance of from 2 to 6 times the diameter of the peritreme area; collum with an anterior row of large tubercules, behind which is a distinct transverse depression.

Male gonopods with the prefemur and femur coalesced into a rather stout, straight, and unmodified trunk, terminating distally in a large flattened tibiotarsal blade and a tapering, slender solenomerite branch. The genus is especially characterized by the fact that these terminal elements are bent in a direction *away from* the coxal portion of the gonopod. The impression given is that of an arm bent at a right angle at the elbow, with the thumb and opposed cupped fingers pointing away from the shoulder. In the genus *Platyrhacus* the tibiotarsus and solenomerite are bent in the opposite direction—back toward the coxa.

Synonymy.—Attems (*op. cit.*, p. 226) grouped almost all the American platyrhacids in a subgenus to which he applied Cook's name *Tirodesmus* (type, *fimbriatus* Peters). It is felt that this species is quite worthy of generic distinction from the other Neotropical forms (because of the characteristic shape of the lateral carinae as well as the male gonopods); *Tirodesmus* is at present considered to be monospecific.

Chamberlin has recently described several new genera of the family from northeastern Peru. It is apparent from his paper that he did not consider the known diplopod faunas of immediately adjacent countries such as Ecuador and Brazil; furthermore the drawings given for his genus *Ernostyx* are strongly suggestive of the sort typical of *Psammodesmus*. At my request, Dr. Willis J. Gertsch very generously lent the holotype of *Ernostyx moyobambus* from the collection of the American Museum of Natural History. Examination of this specimen disclosed that it is congeneric with the new species of *Psammodesmus* to be described (cf. Figs. 4, 5), and that if my understanding of that genus is correct, *Ernostyx* must fall as a junior synonym.

Species.—Eight.

Range.—Cordilleran region of northwestern South America; from northeastern Peru to the isthmus of Panama.

Psammodesmus schmitti Loomis and Hoffman, n. sp.[3]

Figs. 1–4

Type specimens.—Male holotype in the collection of the U. S. National Museum; collected at Port Obaldia, Province of Darién, Panama, by H. Pittier (around 1914). Two male paratypes, also in the National Museum, from Cana, Province of Darién, collected by E. A. Goldman in June 1912.

Diagnosis.—Characterized primarily by the shape of the tibiotarsal lamina of the male gonopod. Its distal edge is gently arcuate, only slightly extended beyond the level of the solenomerite. In the other known species the distal

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[2] Attems's treatment of the Platyrhacidae leaves much to be desired in the way of consistency. Despite his inclination to reduce the number of supraspecific categories as much as possible, his own groupings are not always defensible. A case in point is the subgenus *Ozorhacus*, proposed in Das Tierreich (**69**: 253) for the inclusion of 10 species. As shown by the illustrations of the gonopods, none of the referred forms are closely related to the type species (*katantes* Attems). Rather, of them, *amblyodon* and *coelebs* are very close to *singulus* and *microporus*, respectively, which Attems places in the subgenus *Platyrhacus*; *mortoni*, *postumus*, *tetanotropis*, and *sarasinorum* are allied with the group of species (particularly *mediotaeniatus*) placed by Attems in *Psaphodesmus*. Furthermore, *fecundus* and *sterilis* on the one hand, and *arietis* on the other, cannot be allocated to any currently recognized grouping; doubtless generic names will have to be proposed for them.

[3] This species was recognized as new and a description was prepared by H. F. Loomis from the Port Obaldia specimen. On learning of my interest in *Psammodesmus* he kindly forwarded the specimen and his description and drawings. All these have been utilized in the above text, and it seems appropriate to consider the species as described jointly by Loomis and myself.

margin of this part is produced upwards into a pronounced angulation.

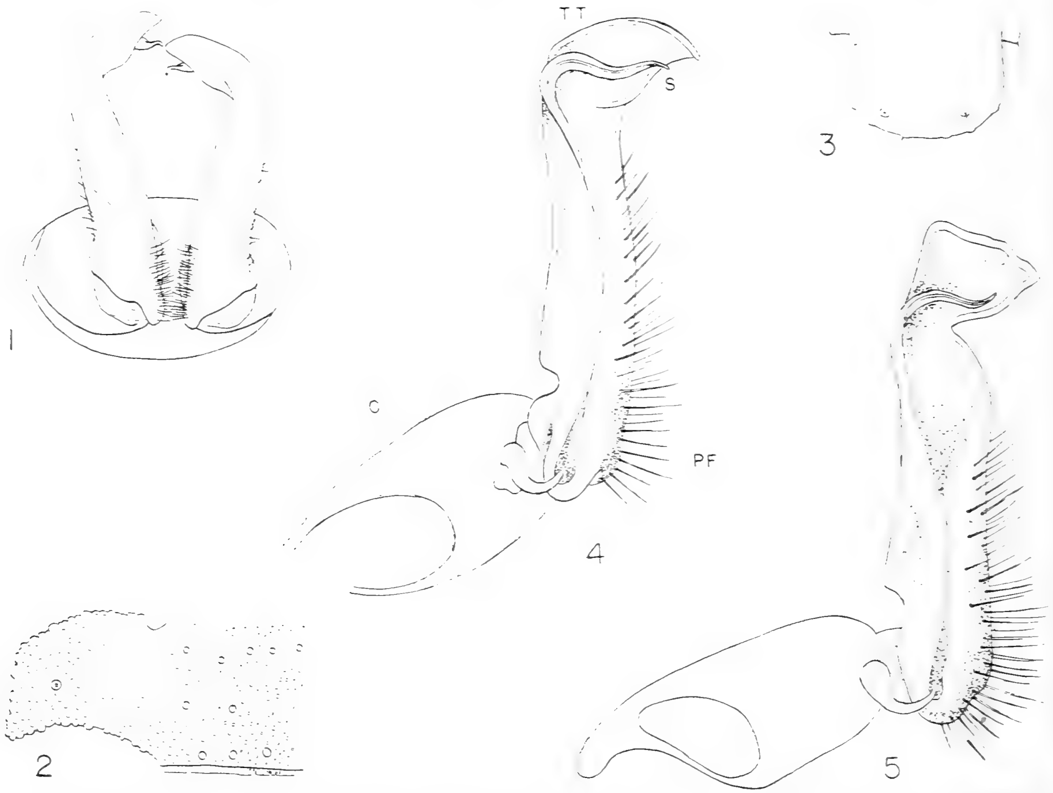
Description of type.—Body 53 mm long and 9.5 mm wide. Dorsum moderately convex; lateral carinae projecting from above the middle of the body, slightly deflexed and extending far from the sides, decidedly broader than long, anterior margin with a prominent square shoulder at the base.

Head with the ridges of the vertex broad, tortuous, converging backward but not quite meeting at the groove; shining-coriaceous clypeal area triangular with the upper angle opposite the lower margin of the antennal sockets; remainder of surface finely tubercular. Antennae relatively long, reaching caudad to middle of the third tergite; articles sparingly hirsute, 2nd to 5th similar in size and shape, 6th very slightly longer.

Collum with the median two-thirds of the anterior margin broadly rounded, the outer sixth on each side straight and bent sharply ectocaudad and with 6 to 8 rounded crenations or nodules; outer fourth of the posterior margin on each side slanting obliquely inward to the transverse median half. Surface of the segment densely beset with small tubercules and a row of 10 to 12 large, rounded, pearllike ones just behind the median portion of the front margin; another row of 8 to 10 similar tubercules near the posterior margin, and the disk with 8 to 10 large scattered tubercules. Behind the depression following the anterior row of tubercules the surface of the segment is raised into a reniform swelling, having the emargination in front.

Succeeding segments with the surface sculpture as on the collum, having large tubercules in a row in front of the posterior margin and scattered ones in front, except on the posterior segments where these tubercules are arranged in two rows in addition to the marginal series. On the posterior segments the smaller tubercules are much less distinct than toward the front of the body.

Lateral carinae considerably broader than



Figs. 1–5.—1, Gonopods, in situ, of male holotype of *Psammodesmus schmitti*, n. sp., Port Obaldia, Panama; 2, lateral carina of tenth segment of same, dorsal view; 3, last tergite of same, dorsal view; 4, left gonopod of same, mesial view (abbreviations: *c*, coxa; *pf*, prefemur; *tt*, tibiotarsus; *s*, solenomerite); 5, left gonopod of male holotype of *Psammodesmus moyobambus*, Moyobamba, Peru, mesial aspect.

long, with a distinct shoulder in front just ectad of the base; posterior angles very gradually increasing in length toward the back. Nineteenth segment with the keels bent caudad and their posterior margins almost longitudinal. Pore formula normal; the pores surrounded by a broad, flat rim (peritreme); pores remote from the margins of the keels—being 4 to 7 times the diameter of the pore area from the outer margin, and 3 to 4 times its diameter from the posterior margin. In the drawing of the carina of segment 10 (Fig. 2) the pore appears about equidistant from the outer and posterior margins. However the downward slant of the carina causes a foreshortening effect and the pore is actually much more remote from the outer than from the posterior margin.

Last segment elongate-rounded; below and at the base of this dorsal production the surface on each side is produced into a distinct setiferous tubercule (Fig. 3).

Anal valves with each raised margin bearing a setiferous tubercule above, and another tubercule on the disk of each valve close to the margin below the middle.

Preanal scale with the anterior production covering a considerable portion of the ventral posterior margin of the last segment; setiferous tubercules of the posterior margin long, closely placed, divergent, the margin between them short, rounded-acute.

Ventral surfaces and legs generally very smooth and shining. Prozonites somewhat longer than metazonites. Legs attached to a small raised area that is noticeably elevated above the level of the prozonite. Spiracles opening through small rounded tubercules, one above the insertion of each leg.

Legs moderately long (apical third of third joint visible from above when legs are extended) and slender, sparingly bristled. Length of joints, in decreasing order of length, 3-6-5-2-4-1. Third joint slightly longer than the basal two. Anterior legs without processes. Tubercules of the sterna between legs 4, 5, and 6 distinctly compressed from side to side, other sterna with rounded tubercules at the bases of the legs.

Gonopods projecting from a rounded-ovate sternal aperture, the posterior margin of which is strongly elevated. Seen in ventral aspect, the gonopods (Fig. 1) appear nearly straight for two-thirds of their length, with the distal third bent at a 45 degree angle mesiad and away from the sternites. Coxae of gonopods rather small, somewhat ovoid, without projections or large hairs. Prefemur and femur inseparable, unless the point of their coalescence is indicated by an indentation on the side near the coxa (this indentation is also present in *moyobambus*). Setose area along outer margin extends about two-thirds the length of the joint, which is robust and relatively straight. Course of seminal channel indicated by a long gently arcuate groove. Tibiotarsus represented by a large, somewhat crescent-shaped blade, the terminal end of which points away from the coxa. The distal margin of this part is arcuate, the free proximal margin concave, as shown in the drawing. Arising at the base of the tibiotarsus is a slender, unbranched, somewhat sinuate solenomerite.

After 40 years of preservation the specimen is completely bleached, and no conjecture can be made concerning the color of the living animal.

Remarks.—The two paratypes from Cana differ slightly in that sternal spines are so faint as to be easily overlooked. In them, too, the tergites show a tendency to be divided into three transverse rows of polygonal areas which are, however, perceptible only with the specimens dried. The gonopods of all three specimens are identical in every respect.

The species is named for Dr. Waldo L. Schmitt, head curator of zoology in the U. S. National Museum, in recognition of his contributions to the knowledge of Middle American Crustacea and in appreciation of his cooperation and assistance which have greatly facilitated my work at the U. S. National Museum.

THE SPECIES OF PSAMMODESMUS

Eight species are at present referable to the genus. It is a matter of some regret that males of the type species are as yet unknown; however, it is believed that *P. cos* can readily be distinguished on the basis of nonsexual characters. Another species is likewise known only from the female sex. This was described by Chamberlin (op. cit) as *Platyrrhacus cainarachus.* The description and figures given, however, agreed so well with the characters of *Psammodesmus* that the type specimen of *cainarachus* was reexamined. I am again indebted to Dr. Gertsch for making this specimen available for examination. It is clearly a species of

Psammodesmus, and very close to *moyobambus*.

In order to summarize what is now known about the genus, I subjoin a tentative key for identification of the species, and a list indicating pertinent literature and distribution.

1. Repugnatorial pores removed from edge of keel by a distance of 5 or 6 times the diameter of the peritreme .... *cos* Cook
   Repugnatorial pores removed from edge of keel by a distance generally not exceeding 4 times diameter of the peritreme 2
2. Lateral margin of midbody keels excavated or indented adjacent to the pores 3
   Lateral margins of keels not excavated or indented 4
3. Dorsal tubercules of normal, moderate size, at most hemispherical in shape
   moyobambus (Chamberlin)
   Dorsal tubercules enlarged, higher than wide and very prominent
   cainarachus (Chamberlin)
4. Solenomerite short, simply arcuate
   chuncho (Chamberlin)
   Solenomerite longer, definitely bisinuate or somewhat sigmoid in shape 5
5. Tibiotarsus of gonopod semicircular or nearly so in shape, its inner edge straight and indented from inner edge of femur, thus exposing base of solenomerite 6
   Tibiotarsus not semicircular, its inner (or distal) margin continuous with that of femur, not exposing base of the solenomerite 7
6. Dorsum dark brown, with the keels lighter
   cameranii Silvestri
   Dorsum dark gray with two paramedian longitudinal light gray stripes
   fasciolatus Silvestri
7. Tibiotarsus subcrescentic in shape
   schmitti Loomis and Hoffman
   Tibiotarsus subtriangular in shape
   dasys (Chamberlin)

PSAMMODESMUS

cos Cook:
  Brandtia, no. 12: 52. 1896.
  Colombia.

cameranii Silvestri:
  Boll. Zool. Mus. Torino **12** (305): 15, fig. 41. 1897.
  Ecuador: San José, Gualaquiza, San Antonio.

fasciolatus Silvestri:
  Boll. Zool. Mus. Torino **13** (324): 4, fig. 6. 1898.
  Ecuador: Río Peripa.

cainarachus (Chamberlin):
  Bull. Amer. Mus. Nat. Hist. **78** (7): 491, figs. 116, 117, 1941.
  Peru: Dept. of Loreto, Río Cainarachi.

chuncho (Chamberlin):
  Bull. Amer. Mus. Nat. Hist. **78** (7): 497, fig. 197A. 1941.
  Peru: Dept. of Loreto, Iquitos.

dasys (Chamberlin):
  Bull. Amer. Mus. Nat. Hist., **78** (7): 497, figs. 193–96. 1941.
  Peru: Dept. of Loreto, Contayo Hills, Río Tapiche.

moyobambus (Chamberlin):
  Bull. Amer. Mus. Nat. Hist. **78** (7): 498, figs. 188–92. 1941.
  Peru: Dept. of Loreto, Moyobamba, Balsapuerto Trail.

schmitti Loomis and Hoffman
  Journ. Washington Acad. Sci. **43:** 301–303, figs. 1–4. 1953.
  Panama: Prov. of Darién; Cana, Port Obaldia.

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VOL. 43 October 1953 No. 10

BIOLOGY.—*Speculation on the cosmic function of life.* A. A. WILLIAMSON, Washington, D. C. (Communicated by Waldo L. Schmitt.)

> "... the demonstration of the existence of a general trend which can legitimately be called progress, and the definition of its limitations, will remain as a fundamental contribution of evolutionary biology to human thought."—JULIAN HUXLEY.

The principles or laws of thermodynamics have been variously stated. The most succinct formulation of the so-called first law of thermodynamics was given by Rudolf Clausius in 1850: that the energy of the universe is constant. This is the principle of the conservation of energy: it can be neither created nor destroyed. Clausius also formulated what is known as the second law of thermodynamics: that the entropy of the universe tends to a maximum. This is the principle of the dissipation of energy, theoretically ending in the "heat-death" of the universe when all energy will be uniformly distributed at a dead level of ineffectiveness.

At first sight, these two laws seem contradictory. For if cosmic energy, however indestructible, tends to reach a common dead level at which it can perform no more work, then is it not thereby reduced to zero? Is not that what the theoretic "heat-death" of the universe actually means, and can it mean anything else? The answer is, of course, that the first law remains theoretically true even after the second has robbed it of practical meaning: the potentiality is still there but it is not "available."

Since the discovery of radiation the theory has been advanced that the effective energy of the universe is constantly being replenished or restored by radiation changing back to matter just as matter is known to change into radiation. Millikan, Smuts, and the mathematician Bishop C. W. Barnes have held this view. It is a "mechanical" theory which, in characteristic fashion, excludes as needless all consideration of animate nature, that world of life of which man is a part. So does Maxwell's proposed sorting of molecules except that it would involve control by intelligence.

One of the greatest if not the most important of the problems of philosophy is to discover and define man's relation to the universe. To explain how he is able to know about it, to perceive and to theorize, is the particular problem of epistemology. Many answers to these problems have been propounded since the early Greeks wrestled with them, and—in the Western World—they have had or lost validity commensurately with their conformity to the scientific knowledge of their time. As advancing scientific knowledge has required readjustments of thought when new and better concepts superseded older, less adequate ones, so have the philosophical and epistemological answers had to change. Science forced it upon them. And so, what with modern advances in science, philosophy may find itself compelled to seek new readjustments in its answers, perhaps even of a basic character.

These matters are not of academic interest only. The vital part played by systematic philosophy in the life of man is now well known. As F. S. C. Northrop has pointed out in *The Meeting of East and West*, the world has come at last to realize, through World War II and its aftermath, that our present "time of troubles" has its roots in conflicts of ideologies or philosophical understandings. By and large, such conflicts have lain close to the roots of war throughout history.

It is the purpose of this paper to outline — to sketch in impressionistic manner almost to the complete neglect of supporting argumentation and therefore dogmatically—a schematic concept, philosophical in character, which, despite its ultimate reliance on speculation, suggests in a new and different way how the energy of the universe may be in a constant process of restoration in effectiveness despite its dissipation. This novel concept may have a special interest because it does include the world of animate nature and finds a specific, even a necessary place for humanity in its philosophical discourse. And lest there be doubt as to the power of biological science to profoundly affect philosophical understandings, it may be well to recall that it was Aristotle, the very father of biology as a science, whose philosophy, powerfully influenced by his biological studies, became basic through St. Thomas Aquinas to the present or later (post-Augustinian) Roman Catholic orthodox doctrine, while it was Darwin who forced basic ideological change upon the modern world.

Through Darwin's insistence upon natural selection as a causative force in speciation, we now have a general acceptance of evolution in lieu of specific spontaneous creation. But—despite shifts away from and back to Darwinism—evolution still has no prophetic meaning. It looks backward, not forward, and few can derive much satisfaction from it as explanatory of man's place in nature's scheme of things and the course of human history, past, present, or future. While some authorities see evolution as a progressive process, their definition of progress (that it consists in greater control over or independence of environment) defines what is actually only a corollary of progress. They also deny that evolution has or can have any End, Purpose, or Objective, thus disregarding the difference between progress and mere progression. Other authorities hold that evolution is not progressive at all but is, on the contrary, regressive. Others, again, look upon it as nothing more than mere change. Evolution thus has its optimistic, pessimistic, and neutral schools of thought.

The uncertainty and confusion of thought thus evident comes, it would seem, from the fact that all three schools fail to take into consideration what has the appearance of being the master biological phenomenon of this planet.

That phenomenon is the so-called "pyramid of life," but especially the great mammalian pyramid to which man belongs and in which he finds his place. This figure of speech is a one-time well known expression epitomizing a biological truism. But, because it was as useless or merely curious an item of knowledge as the equally well known fact that (with only three known constant exceptions) all mammals have seven cervical vertebrae, it fell into disuse and is now so seldom employed as to make it require explanation, which will be made as brief as possible here.

The pyramid of life phenomenon results from two basic facts, with a supplementary third: (1) all living things require food or sustenance for their growth and maintenance; and (2) only vegetable forms of life can manufacture their own food, they having the power to transmute inorganic substance into organic. Therefore all other forms of life depend for their existence upon the green things of the earth, with such negligible exceptions as the sulphur and the iron bacteria as chemoautotrophs.

The supplementary third fact is that animal life evolved in two main, general classes with respect to food sources: herbivores and carnivores.[1] Hence a very large number of plants is required to sustain the necessarily smaller but still large number of herbivores which must die in order that one single carnivore may live. There is thus a diminution of number as life rises, level by level from plant to herbivore and from herbivore to carnivore. The second (herbivorous) level is superimposed upon the first (vegetal) level and the third (carnivorous) level is superimposed upon the second. This superimposition of level on level, together with the necessarily consequent diminution of number, is what gives the pyramid its figurative name.

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[1] "In general, land animals fall rather sharply into herbivores and carnivores, and omnivorous types are exceptions rather than the rule." ALLEE, EMERSON, PARK, O., PARK, T., and SCHMIDT: *Principles of Animal Ecology*, p. 241. Philadelphia, 1949.

Each individual carnivore is the capstone of its own pyramid, but the phenomenon is world wide and so all those little, individual pyramids may be envisioned as components of one grand pyramid of worldwide extent. It is, however, a truncate pyramid, having no apex of numerical singularity.

Since there are many carnivore-including categories of life forms—birds, reptiles, fishes, insects, mammals, and so on—there are a corresponding number of particular pyramids, at least one for each such category, and the more primitive the category is, the less distinctly formed is its pyramid. But the only one which concerns us here is that one to which the mammals, including man, belong. For it alone has carried pyramid construction beyond the carnivorous level in such a way as to give promise of eventually producing an apical capstone for that worldwide structure. In so doing, it will more surely confirm what is here contended: that biological evolutionary progress is factual; that its perpetual landmarks are the successively superimposed levels of the grand, mammalian pyramid of life; and that the End toward which that progress marches is that pyramid's adumbrated eventual apex.

By and large, wherever there are plants, there also are feeders upon them; and wherever there are enough such feeders to sustain it, even briefly, there will carnivorous life be also. Thus the areas of aggregate territorial dominion are, in effect, the same for all three levels, and by identity. But each individual member of a superimposed (evolutionarily superior) level will, on an average and as compared with individual members of its imposed-upon level, exercise a greater expanse of that territorial dominion the assertion and maintenance of which is the price of existence among the living, a universal law of life with a wide range of application but no exceptions. This successive augmentation of individual territorial dominion, level by level, follows necessarily from the domination of the same territorial aggregate by a diminished aggregate of dominators. It is, indeed, simple arithmetic, for when the same dividend of aggregate dominion is divided among a decreased number of dominators as divisor, the quotient of average individual dominion must increase in inverse proportion. (Halving the divisor doubles the quotient.)

Now, the atoms of physical matter are emergents in the sense of William Morton Wheeler's definition, which states that emergence in the scientific sense is "a novelty of behavior [new properties] resulting from the specific interaction or organization of a number of elements, whether inorganic, organic or mental, which thereby constitute a whole as distinguished from their mere sum or 'resultant'." For atoms are constituted of electrons, protons, neutrons, and so on, all specifically interacting to form a whole.[2]

The physical organisms of animate nature are also emergents in the same scientific sense, for they are constituted of cells, whether they be plants or animals and including biological man, the herbivorous and carnivorous levels of the pyramid being most fundamentally differentiated by their mode of securing sustenance. But the habits of predators require of them the constant exercise of superior mental powers. "It takes brains to stalk a prey; if the would-be eater is more stupid than his potential dinner, his chances are poor," says Alfred S. Romer in *Man and the Vertebrates.* Thus, it appears to be in carnivorous animal life that mind begins to assume particularly significant evolutionary value in the pyramid-building process, it becoming highly significant in man.

There are anatomical and historical reasons for believing that man had a carnivorous ancestry, and that he did not "come down from the trees," for he never was in them, as (among others) the African fossil primate known as *Proconsul* appears to indicate (W. E. Le Gros Clark). Man's erect posture seems to have been made possible by the shorter, less bulky and ponderous intestines characteristic of carnivores in general, as is also the frontal eye-placement permitting stereoscopic vision and favoring brain-case enlargement. These useful effects of the predatory habit, to which they are especially valuable, seem to be man's by inheritance. Not just meat-eating, but the morphological effects of the hunting habit

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[2] Emergence, sometimes called epigenesis, violates the maxim that there can not be in the consequent anything more than or different in nature from that which was in the antecedent.

helped materially in making man the dominant physical organism that he is, and on a world wide scale.

All physical organisms—plants, animals, and human beings—when they die, make a final return to the general "atom bank" of the universe, that return consisting of the chemical elements composing their bodies at the time of death. This is a residual reversion back to matter by the disintegration of produced effects.

Expositions of the biological evolutionary process commonly carry it up to man and there they stop. There, "natural history" ends and "human history" begins. The general biologist is through, and the experts of the various disciplines which (in English-speaking countries) come under the omnibus heading of anthropology take over. In one way or another they all study man as what Aristotle said he is: namely, "a political animal," which means one given to social organization.

Man shares with certain insects the distinction of being able to create societies which are just as much emergents in the sense of Wheeler's definition as are atoms and physical organisms, being wholes or individualizations resulting from the specific interaction or organization of their constituting, living elements and exhibiting new properties as a direct consequence, in cultures and civilizations. It is worthy of note that the power of a human culture to advance to civilization seems to hinge upon its ability to accumulate and exploit conservable, need-supplying surpluses. These have been called "margins of vitality,"[3] and they may be of a material or an ideational character. The greater their number and diversity, the higher and more complex may be the stage of civilization attained.

In all societies the family appears to be the basic unit, comparable in that respect to the cell of physical organisms and to the atoms of matter. But the societies of the social insects are only grandiose families, and, being fiercely hostile to strangers even of their own kind, they have never produced more broadly constituted societies, whereas man has. The most stable large-scale human social organization is the nation, and the position here taken is that nations, however constituted politically, are true organisms which, in aggregate, form a new and higher level in the mammalian pyramid of life, thus carrying the evolutionary process on *beyond man* as an accomplished fact. In the pyramid of life so viewed, national societies constitute a level higher than and superior to man by the same general, source-of-sustenance criterion of superiority valid with respect to other levels in it, that sustenance now being the aggregated, composite mental activity of the human sustainers, institutionally embodied and organized. But individual man, in the role of sustainer, has an evolutionary priority which cannot be reversed and which steadily becomes increasingly significant, even from the strictly evolutionary point of view, as the sustenance-supplying value of cultivated human intellects is more and more heavily accented in the course of history and democracy as a political system (which alone it is) approaches the ideal of private liberty and public order successfully maintained in balance, one against the other.[4]

Analytical study of the mammalian pyramid of life up to and including the level of the carnivores reveals the following principles, which appear to be universal with respect to it:

I. The law of territorial dominion. (In one or more of a great variety of possible ways, every individual must rule the source of its sustenance or lose its liberty if not its life.)

II. All evolutionary superiors depend for their existence upon the prior and continued existence of their evolutionarily inferior sustainers. (A lower level must precede a higher.)

III. Diminution of number, level by level.

IV. Identity of aggregate territorial dominion for all levels. (Each level must finally establish worldwide dominion.)

V. Increased individual territorial dominion in inverse proportion to diminution of

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[3] Haskins, Caryl P.: *Of Societies and Men*, p. 231. New York, 1951.

[4] Public order (governmental organization) is essential to community life, while the greatest degree of private liberty consistent therewith alone can give effective expression to those superior, creative mentalities which may appear sporadically in all levels of society by whatever criterion and which cannot be predicted. Only democracy can well assure both these desirables.

number. (A necessary consequence of III and IV as previously noted.)

All these principles apply with full force to societies, both insect and human, and, in this paper, nations, as true organisms, are held to constitute a new level of existential reality: the mental or psychozoic.

It was when man, adopting systematic agriculture, began to form sedentary societies that he was forced to become definitely omnivorous, just as were the nesting ants despite their carnivorous ancestry, they having evolved from wasps. For only vegetable sources can furnish the abundant and dependable food supply required by a populous, permanently located society, while meat-hunger persists for both phylogenetic and physiological reasons, meat still being man's most perfect natural food.

It has been argued (among other reasons) that nations do not qualify as organisms because they have no natural span of life. But there are arguments, not adducible here, which, in rebuttal, suggest that should nations actually have such a life span, history is still too brief to reveal it. Nations do, however, cease to be, and when they do they may leave archeological remains comparable to the fossil remains of physical organisms. Here, too, there appears to be a residual reversion to the "atom bank" of the universe, also by the disintegration of produced effects.

In recent years the vision of a unitary World Order has risen once again as it has risen repeatedly in the mind of man through the ages. There is reason to believe that realization of that vision is at last approaching the possible but that it is contingent upon the prior formation of (cultural?) regional supranational organizations if not organisms. Only when they first shall have been constituted in permanence does it seem probable that the vision of One World can later be realized. And in that realization, far in the future though it now may lie, our planetary mammalian pyramid of life will find its apex.

One of the greatest obstacles to such realization is that only democratic nations as known in the West seem able to cooperate in harmony, wherefore they alone appear to give promise of carrying the process to its apical End, its Final One of diminution of number, and democracy is still only a Western phenomenon. But back of that lies the still greater difficulty that One World cannot permanently eventuate until one basic philosophy is common to the nations. The pyramid of life concept—giving meaning to the evolutionary process such as it does not now have and stressing the cooperative, organizing impulse as primary therein—could become the cornerstone of such a philosophy, rooted in natural law and growing logically from it as all valid philosophies must, or must appear to in the light of the scientific knowledge of their time.

The pyramid of life concept, however, will not be adequate if it can be said that it is valid for our planet alone. No matter how much its present faults (the inevitable concomitants of innovational incipiency) may be corrected and its truths elaborated and confirmed, even to the point of gaining for it a general acceptance, it will still remain a fact that the earth is but an infinitesimal part of the universe. What happens here may be quite insignificant as measured against the immensity of the cosmos. And modern scientists are cosmic minded. There has lately been a veritable spate of mathematically conceived cosmologies: Einstein's, de Sitter's, Le Maitre's, Tolman's, and others. Latest of all is Hoyle and Lyttleton's.

Astronomical science no longer asserts that the earth is the only inhabited planet. Most of our leading astronomers now agree that there are literally thousands of planets scattered through the cosmos on some of which life as we know it not only can but probably does exist. And that is interesting indeed, for *life as we know it means pyramid-building life!* Perhaps those "dark companions," especially those planets which are life-bearing planets, may have greater significance than we yet realize. The very numerosity of them would seem to suggest some cosmic relation in life's evolutionary process.

These are problems whose answers we may never know with any degree of certainty. But the mind reasons. It imagines and theorizes. Indeed, the first step toward the formulation of scientific theory often is the use of the imagination to make tentative, exploratory guesses. It is legitimate so to use the imaginative faculty if it is logically employed and its fruits subjected to such experimental or observational tests as can be devised. Should that be impossible, there can be no more than a hypothesis, not even a working hypothesis but merely speculation pure and simple. Yet that, too, can serve if it must. So let us consider.

One of the characteristics of the pyramid of life as we know it is that there is an evident successive refinement and concentration of energy in the form of sustenance and "margins of vitality" as life rises through its realms and levels, its source-of-sustenance-determined fields of actuality. It may therefore not untruthfully be said that by the worldwide pyramid-building process life gathers and builds up energy stores in more and more concentrated-by-refinement form: from gross vegetable matter to animal; from animal to self-conscious, perceptive mentality. Thus are created the vegetable kingdom, the animal kingdom, and the kingdom of the mind. And always there appears to be a residual reversion back to the universal "atom bank."

If, now, this is not merely an isolated phenomenon but is a cosmic one, then may it not be possible—and here imagination takes wings indeed!—that as planetary pyramids evolve their apical capstones there is another, a fourth transmutation, by which energy is still further refined and concentrated, to be sent forth to sustain some Ultimate Unity of the Universe, the Final One of *cosmic* diminution of number, a cosmic Final One whose area of territorial dominion is the cosmos itself? And if again there is that residual reversion after use, would it not most probably be in the form of the stuff of which the "dead" matter of the physical universe is made?

Wild as this speculation may seem, there may be more than a little truth in it. It might, for example, account for that new hydrogen which Hoyle and Lyttleton's mathematical cosmology postulates as continually appearing but coming from they know not where. For hydrogen is the commonest, most plentiful and, at the same time, the most basic of all the chemical elements. It is out of hydrogen "pennies" that the larger "coins" of the "atom bank" of the universe are made, releasing the "packing fraction" energy of fusion in the process.

Should all this be indeed true, then it would seem that life has a cosmic function by which the operation of the second law of thermodynamics is offset and counteracted, reminiscent of Newton's law of action and reaction. Thus may the "heat death" of the universe be made forever impossible.

Here we are dealing with something akin to the postulated existence of God: no one can prove it, but neither can anyone disprove it. Yet the charge of insufficiency of theoretic range of applicability of the pyramid of life concept can at least be met and challenged.

Objections to this speculative conclusion can, of course, be raised. Only two will be noticed here.

First, the expanding universe theory based on Hubble's observed shift to the red end of the spectrum, increasing with distance, is now seen to require the continual appearance of new hydrogen in order to keep the average density of the matter of the universe constant despite that expansion, and the velocities involved are so great that far more hydrogen is required to appear than any conceivable number of planetary life pyramids could possibly supply by any process of transmutation and residual reversion. Any such speculative conclusion is therefore completely negated by the expanding universe theory.

In rebuttal, it can be said that the expanding universe theory is only one of several scientifically satisfactory explanations of that "Doppler effect." It might, for example, actually be a sort of "Compton effect' produced by the passage of the light rays through the intervening "cosmic dust," reducing their energy and lengthening them, an effect also increased by distance. The expanding universe theory objection is of questionable validity.

Second, no reference to life is necessary since the newly appearing hydrogen is held to be a true creation, being made *out of nothing*, says Sir Harold Spencer Jones, British Astronomer Royal.[5] This is indeed a bold, almost an outrageous assumption. How desperate must the case be when such measures have to be resorted to! One is reminded of

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[5] *The Listener* (July 17, 1952), London. Condensed in *Science Digest*, November 1952, p. 56.

Bertrand Russell's remark: "It is the privilege of pure mathematicians not to know what they are talking about." Compared to this, the demands upon credulity made by the speculative conclusion advanced in this paper as to life's cosmic function are mild indeed! And it does not require nullification of the first law of thermodynamics, as this postulation of such newly created hydrogen does. What it does require is merely that the evolutionary process should continue to operate precisely as it has through countless millennia and follow the same general pattern with that consistency for which nature is famous.

Brushing aside now the thousand and one objections of detail which can be raised against the pyramid of life concept (most of which seem to have their satisfying answers), let us turn to an aspect of it which may escape notice. It is that through that concept we can have an idea of how the mechanical, chemico-physical world of matter and the world of animate nature are joined at—so to speak—both ends of the latter. Their differentiation begins when inorganic substance is transmuted into organic. Then the process of building up the grand, mammalian pyramid, supported by lesser, subsidiary ones, proceeds in an ordered manner, gathering and concentrating energy as it rises. It ends in the pyramidal finality of numerical singularity and the fulfillment of its cosmic function by (the electromagnetic forces of?) life. Then, by residual reversion, matter returns to its condition at the starting-point, closing the cycle of this continuous process. Thus do we obtain an idea of the animate and inanimate worlds as complementary phenomena, two interacting, reciprocal parts of one great whole.

Is it not time for cosmologists, mathematical or otherwise, to take notice of the fact that life, too, may be of cosmic significance, and to admit consideration of it into their calculations? It would seem so.

PALEONTOLOGY.—*Notes on some Mesozoic fossil fish remains from Mexico.*[1]

David H. Dunkle, U. S. National Museum, and M. Maldonado-Koerdell, Petroleos Mexicanos.

The remains of two identifiable fossil fishes have been recovered recently from horizons in the sequence of upper Jurassic and lower Cretaceous rocks near Tamán, San Luis Potosí, Mexico. The surprisingly deficient record of marine fishes of these ages in the Western Hemisphere has prompted study of the present materials and suggested the desirability of publishing the following observations.

The region about Tamazunchale and Tamán in the State of San Luis Potosí has attracted the attention of several geologists during the past 30 years. Heim (1926, pp. 84–87, 2 figs.) was the first to offer a gross account of the rock formations outcropping between Tamazunchale, Tamán, and Pimienta, a village on the Río Moctezuma a short distance southwest of Tamán. In the geologic column elaborated from his field observations, Heim recognized a thick sequence of Jurassic sediments overlain by a limestone which although very similar to the Tamasopo limestone was given the new name Tenestipa formation and considered, according to the ideas of the time, of lower middle Cretaceous age. The Jurassic section was conceived as of two parts; a lower formation called the Tamán beds assigned a Kimmeridgian age on the basis of fossils collected in the valley of the Río Moctezuma at and east of Tamán; and an upper unfossiliferous formation named the Pimienta beds tentatively referred to the Portlandian stage of the upper Jurassic.

Burkhardt (1930, pp. 90–91, fig. 28) in speaking of the Tamazunchale-Tamán section, stated that the Jurassic strata there were simply the northwestern extremity of outcrop of the Liassic and "suprajurassic" formations of the Huasteca region. In addition he considered the highly folded and faulted Tamán beds, reported by Heim as measuring more than 1,000 m in thickness,

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[1] The original fish specimens herein described are retained in the private collection of the junior author. Replicas, however, have been deposited in the U. S. National Museum.

to be equivalent to the rocks at Mazapil, Zacatecas, containing *Haploceras fialar* (Oppel) and the bivalve genus *Aulacomyella*. No reference is made by Burckhardt to the unfossiliferous Pimienta beds of supposed Portlandian age.

In Muir's work (1936, pp. 13–15) a transcription of Heim's interpretation of the geology of the area was given with additional information on some cephalopods which had been collected on the newly opened Mexico-Laredo Highway some 10 km. southwest of Tamazunchale and studied by W. S. Adkins. Following this latter contribution, Heim (1940, pp. 332–334) published a second description of the section which was, in general, a repetition of his original conclusions.

Imlay shortly thereafter (1943, p. 1513) expressed the opinion that the region was worthy of thorough investigation in order to determine whether or not valid names for stratigraphic units had been used or if new names should be introduced along with correlations with well established zones elsewhere in Mexico. He subsequently discovered numerous cephalopods in the brown tuffaceous and calcareous beds containing thin bands of black chert along the highway southwest of Tamán. In his opinion (Imlay, 1952, p. 971) these fossils, derived from part of the Pimienta beds of Heim and identified as *Paradontoceras*, *Substeuroceras*, *Himalayites*, *Corongoceras*, *Hildoglochiceras*, *Pseudolissoceras*, and *Durangites*, served to confirm the presence of the Portlandian in the Tamazunchale-Tamán region. In regard to the Tamán beds, Imlay (1952, p. 971) also accepted their Kimmeridgian age as evidenced by fossils (*Haploceras fialar* (Oppel), *Sutneria* sp., *Aspidoceras* sp., and *Aulacomyella* sp.).

In the same year Maldonado-Koerdell (1952, pp. 234–239) gave an account of the stratigraphy of the Tamazunchale-Tamán section, as a result of a systematic search for fossils along the Río Moctezuma and the Laredo highway. Cephalopods, bivalves, and fishes, two of which are described in this paper, were collected, indicating the presence of several levels of Cretaceous and upper Jurassic beds. The following description is a summary of his interpretation of the geologic column between Tamazunchale and Tamán, including a few kilometers of the highway to the southwest of Tamán.

1. *Méndez shales*. Along the highway in Tamazunchale, and northeast of that town, shales of upper Cretaceous age, with *Globotruncana cretacea*, *Globigerina* sp., *Marssonella oxycona*, *Gumbelina excolata*, *G. globosa* and *Gyroidina* sp., outcrop in exceedingly well preserved condition. The basal portion of the formation, with a certain amount of calcareous beds, should be considered as transitional with underlying strata. The age of the shales is Maestrichtian and Campanian, according to the general consensus of opinion among oil geologists in Mexico.

2. *San Felipe limestone*. Very characteristic layers of uniform thickness, between Kms. 358 and 357 of the Laredo highway, to the southwest of Tamazunchale, are shown in a quarry. Their basal portion is highly folded and faulted. The San Felipe limestone is Senonian in age.

3. *Agua Nueva limestone*. Exposed in the same quarry with the overlying San Felipe and similarly folded and faulted, there are some 15 m of a black, shaly limestone, with pyrite concretions and badly preserved impressions of *Inoceramus labiatus*, of Turonian age.

4. *Tamaulipas limestone*. Underneath shales and limestones of upper Cretaceous age, a thick sequence of a gray, finely grained crystalline limestone, with thin bands of black chert in the higher portion, and a certain amount of shaly and other impurities in the lower portion, outcrops along the highway and the river for more than 20 kms. The limestone is tremendously folded and faulted, but after some familiarity with the section is acquired, it is not difficult to follow downwards the sequence of beds, and to recognize at least two levels or portions in the rocks. The higher portion shows a tendency to maintain the typical lithology of the upper Tamaulipas limestone, while the lower portion is mixed with impurities of diverse nature, and has rounded or flattened concretions of variable dimensions, in more or less abundance, in the lowest levels. Fossils like aptychi of at least two cephalopods, bivalves, and one of the fishes here described, were found in this portion of the limestone, which provisionally has been ascribed to the

Neocomian, in view of positional relationships.

The interval between the lower portion of the limestone and the Tamán beds is everywhere covered in the near vicinity of Tamán, on the highway and the river. Should the Pimienta beds of Heim and Imlay be found close to the village, and their Portlandian age confirmed, their place would come between nos. 4 and 5 of this column.

5. *Tamán beds.* On the bottom of the Moctezuma canyon, east and west of Tamán, well-defined beds of a black-gray limestone of variable dip and strike crop out on the south side of the river. They represent the top of an anticline, oriented from southeast to northwest, and also contain aptychi, cephalopods, and the other fossil fish of this report. Their age is Kimmeridgian.

Order PYCNODONTOIDEA

Family Pycnodontidae

Genus **Gyrodus** Agassiz, 1844

(Refer to A. S. Woodward, 1895, p. 233, for generic synonymy and diagnosis.)

Gyrodus cf. **G. macrophthalmus** Agassiz

An incomplete right mandible with complete splenial dentition illustrated in Fig. 1, exhibits well the fundamental characteristics of the assigned genus.

The presence of an associated dentary element is uncertain. As incompletely preserved and exposed in ventral aspect, the splenial bone has an over-all length of 43 mm and a maximum width of 14 mm. The dorsal surface is occupied for about two-thirds of its extent by the tooth studded area. This dentigerous portion appears flat without either transverse or frontal flexure and presents an elongate, trapezoidal outline only slightly broader behind than anteriorly and with the posteriorly diverging mesial and lateral borders of about equal length.

Although showing some small irregularities, all the teeth are generally circular in coronal outline. Each exhibits either an apical pit or tubercle surrounded concentrically by two elevated and mammilated rings. They are set in four regular longitudinal rows. In each of these four linear series the structures show a progressive increase in diameter from front to back. As usual, counting from the symphysis laterally, the second row contains the largest teeth. The fourth or labial row is made up of the next to the largest. This greater size causes the crowns of the teeth in these two rows to project noticeably above the levels of those of the symphysial and third rows. The symphysial row is composed of 11 well spaced teeth; the second, 8; the third, 10; and the fourth, 9. It is of interest to note that the lateral fourth row has the shortest longitudinal dimension of any in the dental battery. Its component teeth are all flattened on their labial side and the crowns above these lateral points are raised into cusplike eminences which interrupts the continuity of one or both of the concentric mammilated rings.

Geologic horizon and locality.—Collected from the type section of the Tamán beds (Kimmeridgian) (Heim, 1926 and 1940) on the right bank of the Rio Moctezuma at the village of Tamán, San Luis Potosí, Mexico, by M. Maldonado-Koerdell and D. H. Dunkle, October 1951.

Discussion.—Numerous species of pycnodontid fishes, varying in age from the middle Jurassic to upper Cretaceous, have been referred to the genus *Gyrodus*. The majority of these, unfortunately, have been based on unassociated splenial and vomerine dentitions and defined without adequate information on the quality and quantity of variation shown by the few species known by series of complete skeletons. For the purpose of this report, therefore, no attempt at detailed specific comparisons has been made. The present assignment of this Mexican specimen to the contemporaneous genotypic species *macrophthalmus* is entirely arbitrary although the generic reference cannot by current criteria be questioned.

Two occurrences of *Gyrodus* in the Western Hemisphere are listed by Romer (1945, p. 580). Of these two, the questioned upper Cretaceous occurrence in North America has not been located in the literature. However, the other, upper Jurassic one refers to *Gyrodus macrophthalmus cubensis* Gregory (1923) from the Jagua shales of Western Cuba. This latter pycnodontid fish is very poorly known but extensive series of specimens now available, while showing tremendous variation in dental characters, seemingly differs constantly from the Mexican type, as follows: the labial row of splenial teeth is the longest of the four linear series present and contains the greatest number of component denticles which never appear appreciably enlarged; and the teeth, especially those of the principal row, tend toward

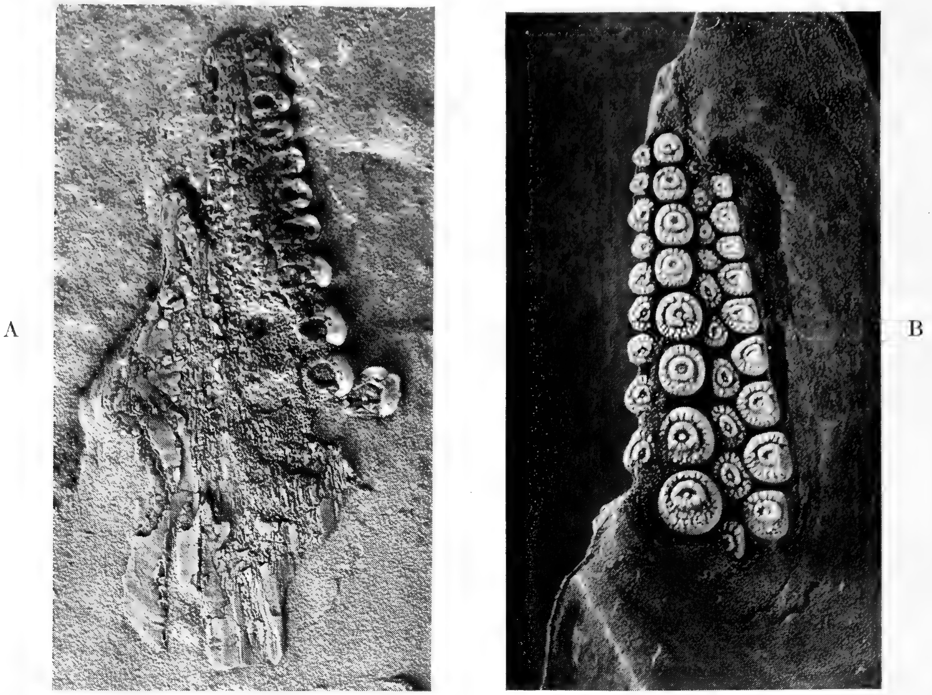

FIG. 1.—*Gyrodus* cf. *G. macrophthalmus* Agassiz. Lingual (A) and crown (B) views of fragmentary right mandible from the type section of the upper Jurassic (Kimmeridgian) Tamán formation at Tamán, San Luis Potosí, Mexico. × 2.

an ovoid outline through increase of the transverse diameter of the crowns.

Order ISOSPONDYLI
Suborder Clupeoidea
Family Leptolepidae
Genus **Leptolepis** Agassiz, 1832

(Refer to A. S. Woodward, 1895, p. 501, for generic synonymy and diagnosis.)

Genotype: *Leptolepis coryphaenoides* (Bronn).

Leptolepis tamanensis,[2] n.sp.

Diagnosis.—A leptolepid as shown by anteriorly attenuated frontals and characteristically developed mouth parts which differ from the genotype and all adequately known Jurassic leptolepids from the Western Hemisphere by possession of the following combination of structural features: vertebrae, with minute notochordal perforation, heavily ossified and generally longer than deep; only the last four centra involved in support of the externally homocercal tail; no demonstrable urostyle or uroneurals; the five hypurals supporting the dorsal lobe of caudal fin abutting directly on the last recumbent neural arch and two spineurals; the four hypurals supporting the ventral lobe arising from the last three vertebrae; and all 20 of the articulated and branched caudal fin rays hypaxial, and preceded directly both dorsally and ventrally by series of small fulcra-like spinelets.

Holotype.—An incomplete fish on slab of tuffaceous matrix showing major visceral components of the head and an articulated series of vertebrae with attached caudal fin; from the lower Cretaceous (Neocomian) beds at Kilometer 342 + 650 on the Mexico-Laredo Highway, above the village of Tamán, San Luis Potosí, Mexico; collected by M. Maldonado-Koerdell, August 1951.

Description.—The structural details of the one known specimen on which this type description is based are somewhat obscured by secondary mineralization. Accurately discernible, however, are the major visceral components of the head, a cleithrum, and an articulated series of vertebrae with attached caudal fin. Compared with the averaged dimensions of several species of *Leptolepis* an elongate fusiform fish is indicated with head occupying perhaps 20 mm of a standard length estimated as about 90 mm.

The form and disposition of determinable skull elements are illustrated in Fig. 2. Characteristic

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[2] Named for the village of Tamán, San Luis Potosí, which is near the occurrence of the holotype.

of the family to which the form is referred are the anteriorly attenuated frontals; the small premaxillary; the maxillary with anteriorly constricted neck and posteriorly convex oral border; and the distinctive, dorsally produced dentary. The orbit appears to have been large and situated centrally in the length of the head. The angle of the lower jaw lies below the middle of the orbit. The maxillary was probably of normal leptolepid size, although as preserved overlain by the mandible, its observable extent scarcely equals the preorbital length of the skull. Teeth are not to

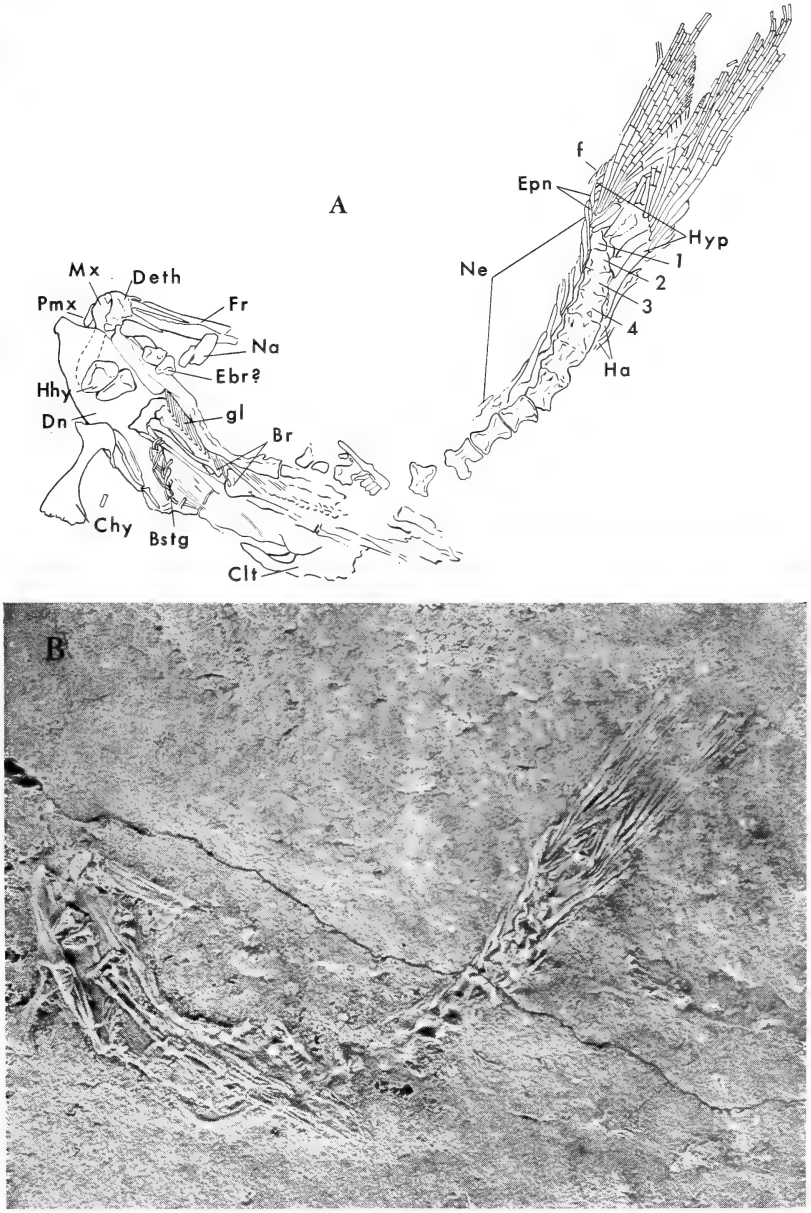

Fig. 2.—*Leptolepis tamanensis*, n. sp. Habit sketch (A) and photograph (B) of specimen as found, in here interpreted lower Cretaceous strata, at Kilometer 342 + 650 above Tamán, San Luis Potosí, Mexico. × 2. (Legend of abbreviations: Br, branchial arch elements; Bstg, branchiostegal rays; Chy, ceratohyal; Clt, cleithrum; Deth, ?mesethmoid plus dermethmoid; Dn, mandible; Ebr?, paired epibranchial elements; Epn, epineurals; f, spinelets in advance of both dorsal and ventral caudal rays; Fr, frontal; Hhy, paired hypohyals; Hyp, hypurals; Mx, maxillary; Na, nasal; Ne, neural arches; Pmx, premaxillary; and 1, 2, 3, & 4, respectively, the last and anteriorly preceding 3 vertebrae centra involved in support of caudal fin.)

be seen on any of the mouth parts. An undoubtedly incomplete series of eight strongly arched and rodlike branchiostegal rays lie adjacent to the ventral border of the right ceratohyal. Long, slender, and closely set parallel rods extend from the surfaces of several of the branchial elements and seem best interpreted as gill raker supports.

The cleithrum exhibits a prominent longitudinal ridge and a relatively large postero-ventral expansion.

Preserved vertebrae number 11. All possess an average length of 2 mm, with the exception of the last three centra which are shorter. This length is greater than the depth anteriorly in the series, but progressively toward the rear is equalled and then exceeded by the dorso-ventral dimension. Each centrum appears to have been heavily ossified, with markedly constricted dorsal and ventral margins, and some present evidences laterally of pits above and below a longitudinal strengthening rib. The internal notochordal perforation is minute.

The structure of the tail is externally homocercal. Apparently only the last four vertebrae take part in the support of the caudal appendage. The neural and haemal arches of this region are robust and are inclined backwardly in acute angles from free articulation with the centra to almost parallel the longitudinal axis of the vertebral column. Each possesses a strong forward process which abuts on the next preceding arch. A total of nine hypurals are present. Neither a urostyle nor paired uroneural elements can be discerned. In consequence, the five upper hypurals supporting the dorsal lobe of the fin appear in direct contact with two epineurals and the last neural spine. Of the four hypurals supporting the ventral lobe, two arise from the last centrum and 1 each from the second and third vertebrae from the back. The fourth forwardly succeeding centrum also bears an enlarged haemal arch, which, however, is directed only to the spinelets preceding the fin rays, ventrally.

Observable caudal rays total 20. These, regularly articulated and branching as many as three times, are presumably all hypaxial. The first ray dorsally and the twentieth ventrally are preceded anteriorly by an incompletely preserved series of fulcra-like spinelets. The fin, in all probability, was equilobate and relative to the degree of posterior emargination, the middle rays have indicated lengths exceeding one-half those of the longest rays.

Discussion.—The widely recognized genus *Leptolepis* is comprised of numerous species of fossil fishes from all parts of the world and from strata ranging in geologic age (Romer, 1945, p. 581) from lower Jurassic to the middle Cretaceous. Despite this apparent commonness of occurrence, it is impossible to obtain from an extensive literature either the detailed morphology of most defined forms or the range of structural variation within the population of any given species. In view of such incomplete knowledge and absence of adequate comparative series of specimens, the erection of new species on fragmentary specimens may well appear to be ill advised. However, on the basis of currently employed taxonomic criteria, the present definition of *L. tamanensis* seems warranted. The characters listed in the above diagnosis readily distinguish this Mexican species from the genotype *L. coryphaenoides* (Bronn) (Rayner, 1937). Excluding the Argentine *Leptolepis australis* Saez as too poorly described for comparison, only two other Jurassic leptolepids are known from the Western Hemisphere: *Leptolepis schoewei* Dunkle (1942) from the Todilto limestone (Oxfordian) of New Mexico and *Luisichthys vinalesensis* White (1942) from the Jagua shales (Oxfordian) of Cuba. Affinity between these two and *L. tamanensis* is suggested by the common absence of a demonstrable urostyle and direct abutment of the hypurals supporting the dorsal lobe of the caudal fin on the neural elements. *L. tamanensis* differs specifically from *Luisichthys* in the details of caudal fin structure. It is distinguishable from *L. schoewei* on the same basis but also noticeably in vertebral structure: all available specimens of the species from New Mexico exhibiting poorly ossified diplospondylous ring centra.

REFERENCES

Burckhardt, C. *Étude synthétique sur le Mésozoique Mexicain.* Mém. Soc. Paléont. Suisse **49–50:** 280 pp., 32 figs. 1930.

de Saez, M. D. *Noticias sobre peces fosiles Argentinos.* Notas Mus. La Plata **4**(Paleont. **19**): 423–432, figs. 1–5. 1939.

Dunkle, D. H. *A new fossil fish of the family Leptolepidae.* Sci. Publ. Cleveland Mus. Nat. Hist. **8** (5): 61–64, pl. 6. 1942.

Gregory, W. K. *A Jurassic fish fauna from western Cuba, with an arrangement of the families of holostean ganoid fishes.* Bull. Amer. Mus. Nat. Hist. **48:** 223–242, 6 figs. 1923.

Heim, A. *Notes on the Jurassic of Tamazunchale (Sierra Madre Oriental).* Eclog. Geol. Helvetiae **20** (1): 84–89, 2 figs. 1926.

———. *The front ranges of Sierra Madre Oriental, from Ciudad Victoria to Tamazunchale.* Eclog. Geol. Helvetiae **33** (2): 313–363, 10 figs., 1 geol. map and sects. 1940.

Imlay, R. W. *Jurassic formations of Gulf Region.* Bull. Amer. Assoc. Petrol. Geol. **27** (11): 1407–1533, 14 figs. 1943.

———. *Correlation of the Jurassic formations of North America, exclusive of Canada.* Bull. Geol. Soc. Amer. **60** (9): 953–992. 1952.

Maldonado-Koerdell, M. *Contacto Jurásico-Cretácico entre las formaciones de Tamán y Tamazunchale, Estado de San Luis Potosí, en sus relaciones con la presencia de yacimientos petroleros.* Mem. Primera Conven. Interamericana Rec. Miner., Mexico, 1951; 234–239, 1 pl. 1952.

Muir, J. M. *Geology of the Tampico Region, Mexico:* 280 pp., 15 pls., 40 figs. Tulsa, Okla., 1936.

Rayner, D. H. *On* Leptolepis bronni *Agassiz.* Ann. Mag. Nat. Hist., ser. 10, **19**: 46–74, figs. 1–14, 1937.

Romer, A. S. *Vertebrate paleontology,* ed. 2: x + 687 pp., 377 figs. Chicago, 1945.

White, T. E. *A new leptolepid fish from the Jurassic of Cuba.* Proc. New England Zool. Club **21**: 97–100, pl. 1. 1942.

Woodward, A. S. *Catalogue of the fossil fishes in the British Museum (Natural History)* **3**: xlii + 544 pp., 18 pls., 54 figs. 1895.

ENTOMOLOGY.—*Notes, new synonymy, and new assignments in American Gelechiidae.*

J. F. Gates Clarke, U. S. Bureau of Entomology and Plant Quarantine.

August Busck's excellent paper on the restriction of the genus *Gelechia*[1] is limited in scope to the treatment of North American species, although a few from Europe that concerned him are included. His studies were further limited by the unavailability of material, particularly specimens of species described by the late Edward Meyrick. Moreover, he made no attempt to include species from South America, which are an important part of the American fauna.

Since Busck's paper was written, the present writer has had the opportunity to examine the types of many of Meyrick's species and those of other authors. The study of these types has revealed previously unrecognized facts which are recorded in the following notes.

The new assignments and other changes indicated below are based on a study of the genitalia. Extensive revisionary studies in the family are necessary, but the present paper makes possible the proper assignment of the species treated.

The genus *Chionodes* Hübner has not previously been recorded from South America, although one species, *C. leucocephala* (Walsingham), is recorded from St. Croix, West Indies. The genus is holarctic in distribution and also occurs as far south as southern Chile.

Genus **Aroga** Busck

Aroga Busck Proc. U. S. Nat. Mus. **47**: 13. 1914.

Aroga bispiculata (Meyrick), n. comb.

Gelechia bispiculata Meyrick, Exotic Microlepidoptera **3**: 23. 1923.

Type locality.—Congress, Ariz.

Remarks.—Meyrick compared this with *Lita variabilis* (Busck) to which it bears a slight resemblance but from which it is structurally distinct. The genitalia of *bispiculata* are characteristically those of an *Aroga* and leave no doubt as to its assignment here.

Aroga speculifera (Meyrick), n. comb.

Gelechia speculifera Meyrick, Exotic Microlepidoptera **4**: 59. 1931.

Type locality.—Hope, Ark.

Remarks.—Known only from the type.

Aroga trachycosma (Meyrick), n. comb.

Gelechia trachycosma Meyrick, Exotic Microlepidoptera **3**: 21. 1923.

Type locality.—Venice, Calif.

Remarks.—In this species the harpe is reduced to a mere nodule emitting a moderately strong seta. The aedeagus is unusually robust and the vesica armed with many strong, short cornuti.

Aroga xyloglypta (Meyrick), n. comb.

Gelechia xyloglypta Meyrick, Exotic Microlepidoptera **3**: 22. 1923.

Type locality.—Venice, Calif.

Remarks.—When he described this species Meyrick stated, "Probably allied to *trichostola*." The latter, however, is referable to *Chionodes* as shown by Busck.

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[1] Proc. U. S. Nat. Mus. **86**: 563–593, pl. 58–71. 1939.

Genus **Chionodes** Hübner

Chionodes Hübner, Verzeichniss bekannter Schmetterlinge: 420. 1825.

Chionodes agriodes (Meyrick), n. comb.

Gelechia agriodes Meyrick, Exotic Microlepidoptera **3:** 350. 1927.

Type locality.—Dividend, Utah.

Remarks.—This species is very near *C. seculaella* (Clarke) but appears to be distinct.

Chionodes clistrodoma (Meyrick), n. comb.

Gelechia clistrodoma Meyrick, Exotic Microlepidoptera **3:** 21. 1923.

Type locality.—Nogales, Ariz.

Remarks.—The female genitalia of *clistrodoma* are somewhat atypical for the genus but certainly the species belongs here, rather than in *Gelechia.* The anterior margin of the ovipositor is clothed with dense, long hairlike setae and the posterior margin bears about 10 long, stout, hooked setae.

Chionodes consona (Meyrick), n. comb.

Gelechia consona Meyrick, Trans. Ent. Soc. London, 1917: 50.

Type locality.—Lima, Peru.

Remarks.—Meyrick believed this to be allied to the North American *unifasciella,* but the latter species is referable to *Aroga.*

Chionodes dryobathra (Meyrick), n. comb.

Gelechia dryobathra Meyrick, Trans. Ent. Soc. London, 1917: 49.

Type locality.—La Crumbre, Colombia, 6,600 feet.

Remarks.—A typical *Chionodes* except for a somewhat aberrant genital opening in the female which, I think, may be regarded only as of specific importance.

Chionodes eburata (Meyrick), n. comb.

Gelechia eburata Meyrick, Trans. Ent. Soc. London, 1917: 50.

Type locality.—La Crumbre, Colombia, 6,600 feet.

Remarks.—Examination of the male genitalia leaves no doubt as to the proper assignment of this species in *Chionodes.*

Chionodes halycopa (Meyrick), n. comb.

Gelechia halycopa Meyrick, Exotic Microlepidoptera **3:** 350. 1927.

Type locality.—Alpine, Brewster County, Tex.

Remarks.—Despite the rather abnormal palpi the female genitalia are typical of this genus and no doubt the species is referable here.

Chionodes icriodes (Meyrick), n. comb.

Gelechia icriodes Meyrick, Ann. Mus. Nac. Hist. Nat., Buenos Aires, **36:** 384. 1931.

Type locality.—Peulla, Llanquihue Province, Chile.

Remarks.—The occurrence of this species in southern Chile represents the southernmost point at which a *Chionodes* is known to exist.

Chionodes lacticoma (Meyrick), n. comb.

Gelechia lacticoma Meyrick, Trans. Ent. Soc. London, 1917: 48.

Type locality.—Chosica, Peru, 2,800 feet.

Remarks.—This small species is similar in aspect to the North American *C. xanthophilella* (Barnes and Busck).

Chionodes litigiosa (Meyrick), n. comb.

Gelechia litigiosa Meyrick, Trans. Ent. Soc. London, 1917: 49.

Type locality.—Huigra, Ecuador, 4,500 feet.

Remarks.—In size and general appearance *litigiosa* is similar to the California lupine-feeding *C. lophosella* (Busck) but may be distinguished from it at once by the absence of raised scales on the forewing.

Chionodes perissosema (Meyrick), n. comb.

Gelechia perissosema Meyrick, Exotic Microlepidoptera **4:** 351. 1932.

Type locality.—Alta Gracia, Argentina.

Remarks.—The genitalia of *perissosema* leave no doubt as to its assignment here.

Genus **Filatima** Busck

Filatima Busck, Proc. U. S. Nat. Mus. **86:** 575. 1939.

Filatima asbolodes (Meyrick), n. comb.

Gelechia asbolodes Meyrick, Exotic Microlepidoptera **3:** 349. 1927.

Type locality.—Alpine, Brewster County, Tex.

Remarks.—A distinct species belonging in the group without sex scaling on the underside of the hindwing of the male.

Filatima collinearis (Meyrick), n. comb.

Gelechia collinearis Meyrick, Exotic Microlepidotpera **3**: 349. 1927.

Type locality.—Alpine, Brewster County, Tex.

Remarks.—There are no described North American species which appear to be closely related to *collinearis*.

Filatima isocrossa (Meyrick), n. comb.

Gelechia isocrossa Meyrick, Exotic Microlepidoptera **3**: 346. 1927.

Filatima virgea Clarke, Journ. Washington Acad. Sci. **37**: 272, figs. 10–10b, 13. 1947. (New synonymy.)

Type localities.—Alpine, Brewster County, Tex. (*isocrossa*); Presidio, Tex. (*virgea*).

Remarks.—The genitalia of this species are distinct, and there can be no doubt *virgea* is a synonym.

Filatima monopa (Meyrick)

Gelechia monopa Meyrick, Exotic Microlepidoptera **3**: 350. 1927.

Filatima monopa (Meyrick), Busck, Proc. U. S. Nat. Mus. **86**: 576. 1939.

Gelechia epigypsa Meyrick, Exotic Microlepidoptera **3**: 351. 1927. (New synonymy.)

Type localities.—Alpine, Brewster County, Tex. (*monopa, epigypsa*).

Remarks.—I have examined the types of both species and the genitalia are identical. Meyrick's *epigypsa* is only a strongly marked specimen.

Filatima nucifer (Walsingham), n. comb.

Gelechia nucifer Walsingham, Biologia Centrali-Americana **4**: 69. 1911.

Type locality.—Sonora, Mexico.

Food plant.—Mesquite (leaves).

Remarks.—I have compared a series of 12 specimens, from South Airport Road, El Paso, Tex., with paratypes of Walsingham's species in the U. S. National Museum collection and they are identical. This is the first record of the occurrence of *nucifer* in the United States but it will undoubtedly be found throughout the southwest wherever its food plant occurs. In addition to the above there are five specimens from San Benito, Tex. (April 1952; P. A. Glick).

The El Paso specimens were reared by J. A. Baker and show the emergence date of August 16, 1951.

Filatima sperryi Clarke

Filatima sperryi Clarke, Journ. Washington Acad. Sci. **37**: 270. 1947.

Type locality.—Barton Flats, Calif.

Remarks.—Since describing this species I have been able to examine six specimens from Mojave County, Ariz. Only one of these, a female, shows the contrasting brown costal area of the forewing and this not so conspicuously as in the type specimens. In one male the brown is slightly indicated but in the others there are only occasional scattered scales or none at all.

Filatima tephrinopa (Meyrick), n. comb.

Nothris tephrinopa Meyrick, Exotic Microlepidoptera **3**: 496. 1929.

Type locality.—Fort Davis, Tex., 5,000 feet.

Remarks.—The brush of second segment of palpus is expanded more than usual for this genus but the male genitalia of *tephrinopa* leave no doubt as to its proper placement.

Filatima ornatifimbriella (Clemens)

Gelechia ornatifimbriella Clemens, Proc. Ent . Soc. Philadelphia **2**: 420. 1864.

Filatima ornatifimbriella (Clemens), Busck, Proc. U. S. Nat. Mus. **86**: 575. 1939.

Gelechia xanthuris Meyrick, Exotic Microlepidoptera **3**: 346. 1927.

Type localities.—"Illinois" (*ornatifimbriella*); Dividend, Utah (*xanthuris*).

Remarks.—This common, variable, lupine-feeding species is found throughout western United States and Canada. The only other described species with similar genitalia is *lepidotae* Clarke, but there are abundant specific differences.

Genus **Gelechia** Hübner

Gelechia Hübner, Verzeichniss bekannter Schmetterlinge: 415. 1825.

Gelechia gracula (Meyrick), n. comb.

Nothris gracula Meyrick, Exotic Microlepidoptera **3**: 495. 1929.

Nothris diaconalis Meyrick, Exotic Microlepidoptera **3**: 495. 1929. (New synonymy.)

Type localities.—Alpine, Brewster County, Tex., 7,000 feet (*gracula*); Fort Davis, Tex., 5,000 feet (*diaconalis*).

Remarks.—Aside from size I can see nothing substantial on which to base specific separation. The genitalia match perfectly.

Gelechia bianulella (Chambers)

Oeseis bianulella Chambers, Cincinnati Quart. Journ. Sci. **2**: 255. 1874.

Nothris melanchlora Meyrick, Exotic Microlepidoptera **3**: 496. 1929. (New synonymy.)

Type localities.—"Texas" (?) (*bianulella*); Fort Davis, Tex., 5,000 feet (*melanchlora*).

Remarks.—The two agree in every respect, including genitalia, and must be considered synonymous. The shape of the tuft of second segment of palpus, on which Chambers based his genus *Oesis*, led Meyrick to describe this and other species of *Gelechia* in *Nothris*. As pointed out by Busck, the genitalia of the latter genus are of an entirely different type.

Gelechia mundata (Meyrick), n. comb.

Nothris mundata Meyrick, Exotic Microlepidoptera **3**: 495. 1929.

Type locality.—Mescalero, N. Mex., 7,000 feet.

Remarks.—This species is very close to *gracula* and may even be a form of it, but more material from the type locality will be necessary to determine that point.

Gelechia thymiata (Meyrick), n. comb.

Nothris thymiata Meyrick, Exotic Microlepidoptera **3**: 497. 1929.

Type locality.—Nogales, Ariz.

Remarks.—This, like the three foregoing species, clearly belongs in *Gelechia* and, on the structure of palpus, is allied to the *bianulella-monella* group of the genus.

ENTOMOLOGY.—*Two new species of mosquitoes from the Yemen (Diptera: Culicidae).*[1] KENNETH L. KNIGHT, U. S. Naval Medical Research Unit No. 3, Cairo, Egypt.[2]

This paper describes the new species occurring in a collection of mosquitoes made by the author while a member of a medical survey team to the Yemen from U. S. Naval Medical Research Unit No. 3. A complete account of this collection is being prepared for a subsequent paper. The larval chaetotaxal nomenclature used in this paper is that of Belkin (1950).

Culex (Culex) mattinglyi, n. sp.

1941. *Culex (Culex) laticinctus* Edwards. Edwards, Mosq. Ethiopian Region **3**: 313. The record from San'a, Yemen (Scott and Britton).

Adult.—A brown species of medium size with sparsely haired male palpi and broad straight pale basal bands on the tergites.

MALE: Wing length approximately 4.5–5.0 mm. *Head:* Proboscis dark. Palpus approximately equal to proboscis in length; dark, a variable amount of pale scaling laterally along apical portion of III and baso-ventrally on IV and V; very sparsely-haired, most of those present being confined to IV; IV and V not markedly uptilted. Vertex with narrow white scales dorsally and broad white scales laterally, upright-forked scales pale brownish. *Thorax:* Scutum with brownish-golden narrow scales, the scales paler in color along the scutal margins and on the prescutellar space. Scutellar scales narrow, pale. *Apn* and *ppn* with some white scales present, usually both broad and narrow. Each of the following pleural areas with a patch of broadened whitish scales: propleural, dorsal sternopleural, medio-posterior sternopleural, dorsal mesepimeral (confluent with hair tuft), and medial mesepimeral. A single lower mesepimeral bristle present (two on one side of each of two specimens). *Legs*: Coxae each with an anterior patch of white scales. Fore and mid femora anteriorly dark except for an apical line of yellowish scales; hind femur with basal half pale except for the dorsal margin and apically, apex with a line of pale scales. Tibiae anteriorly dark except for apical pale patches. Tarsi dark. Fore and mid tarsal claws unequal, each unidentate; hind equal, simple (from slide mount). *Wings:* Dark-scaled. Halter knobs at least partially pale. *Abdomen:* Tergites III-VII with broad straight basal whitish bands. Sternites pale-scaled, scattered dark scaling may be present. *Genitalia* (Fig. 1a, b): Basistyle distinctly swollen; tergal surface bearing a dense covering of short and long setae, outer and sternal surface bearing the usual elongate setae; appendage *a* (terminology of Edwards, 1941: 280 and fig. 103a) markedly proximal to appendages

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[1] The opinions or conclusions contained herein are those of the author and are not to be construed as official or reflecting the views of the Navy Department or of the Naval Service at large.

[2] Now officer-in-charge, U. S. Navy Preventive Medicine Unit No. 1, Naval Air Station, Jacksonville, Fla.

b and *c* and strongly bent medially, appendage *c* distinctly shorter than *b*, appendages *d*, *e*, and *f* absent (possibly represented by three short setae near base of *b* and *c*), leaflet (*g*) and appendage *h* present. Dististyle extremely broadened, with a distinctive recurved portion near apex. Paraproct with an elongate curved basal arm. Phallosome relatively simple in structure.

Female: Wing length approximately 6.0 mm. Differing from the male as follows: Palpi approximately one-sixth to one-fifth length of proboscis, dark. Some pale scaling present basally on

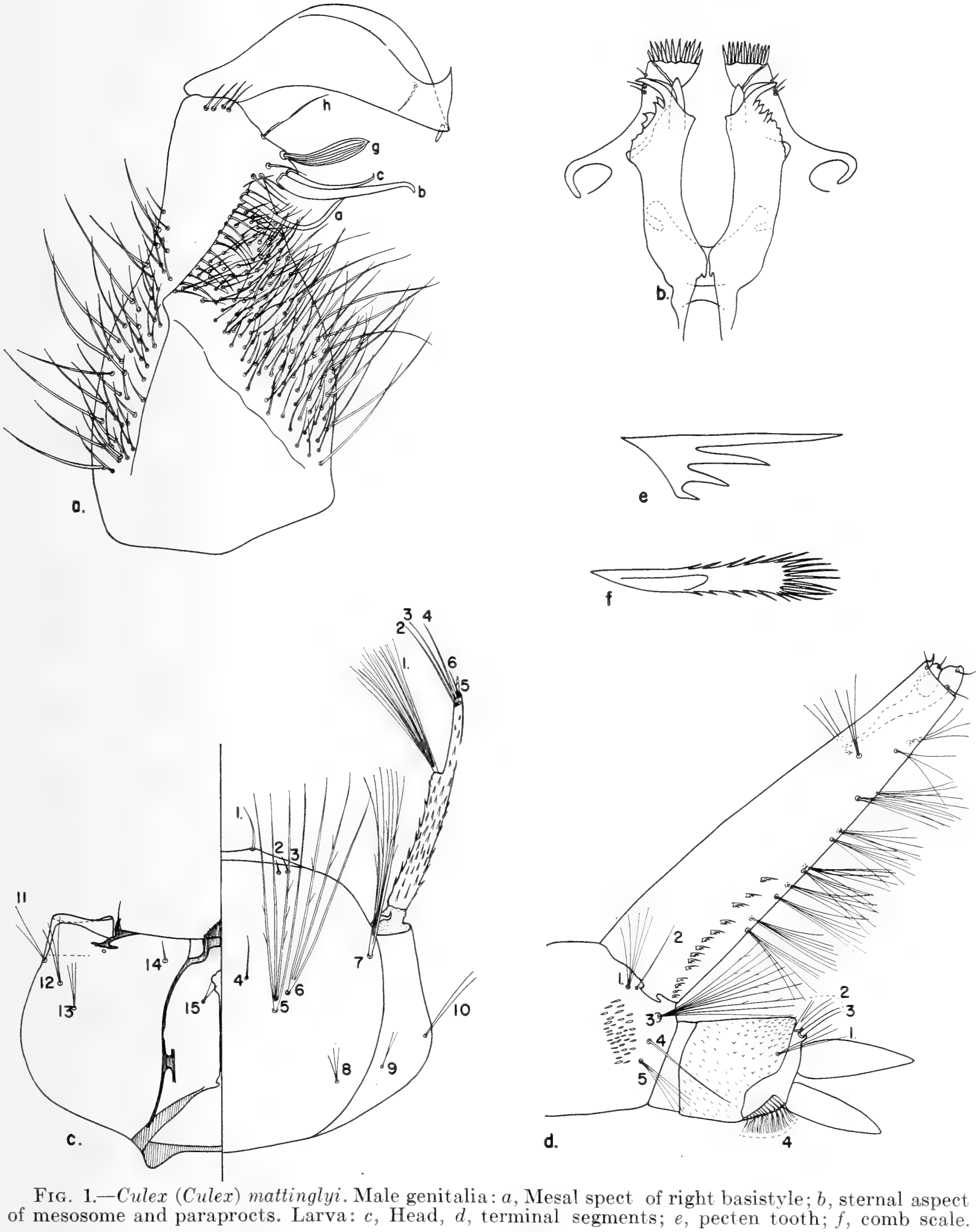

Fig. 1.—*Culex* (*Culex*) *mattinglyi*. Male genitalia: *a*, Mesal spect of right basistyle; *b*, sternal aspect of mesosome and paraprocts. Larva: *c*, Head, *d*, terminal segments; *e*, pecten tooth; *f*, comb scale.

costa. Upper fork cell approximately 3.8–4.3 times longer than its stem. Tarsal claws equal, simple (from slide mount).

Larva (described from 10 skins, representing five separate collections).—*Antenna:* Shaft rather evenly pigmented throughout, densely spiculate from base to level of hair tuft, slenderer and nearly smooth from there to apex. Antennal hair tuft (hair 1) inserted slightly distad of the middle (0.56–0.64 from base), with numerous elongate frayed branches, hairs 2 and 3 distinctly subapical and extending anteriorly slightly further than hair 4. *Head* (Fig. 1c): Clypeal spines single, long, slender; hair 4 single; 5 with 3–7 branches; 6 with 3–6; 7 with 6–9; 8 with 2–4; 9 with 2–6; 10 with 2–5; 11 with 2–5; 12 with 2–3; 13 with 2–4; 14 single; 15 with 2–4. Mentum with 10–12 teeth on each side of median tooth. *Thorax:* Integument with distinct spiculation. *Abdomen, I-VII:* Hair 6 of I with 2–5 branches, hair 7 with 2–3. Hair 6 of II, III, and IV with 2–5 branches, of V and VI with 2–3. *Abdomen, VIII* (fig. 1d, e, f): Hair 1 with 5–7 branches, hairs 2 and 4 single, hair 3 with 9–14, hair 5 with 4–5. Comb consisting of a patch of 34–44 scales, each scale with an evenly-expanding lateral and apical fringe. *Siphon:* Pale; index 3.4–4.5; acus present; 11–16 more or less paired multiply-branched elongate hair tufts present, all latero-ventral except the subapical pair which is lateral, several of the tufts inserted basad of pecten apex; pecten composed of a line of 14–19 teeth, each tooth with 1–3 baso-ventral denticles. *Anal Segment:* Anal plate complete; hair 1 (*lh*) with 2–3 branches; hair 2 (*isc*) with 2–3 branches (once single); hair 3 (*osc*) single; hair 4 (ventral brush) with 12 tufts (twice with 13), each tuft arising from the barred area. Anal gills elongate, subacutely tapered, the dorsal pair 1.2–1.5 the length of the anal plate and 1.0–1.3 the length of the ventral pair.

Types.—Holotype: Male (coll. no. 330), genitalia mounted on a slide, U.S.N.M. no. *61658*, Birket Shiekh Kunnaf, San'a, Yemen, February 13, 1951, elevation 7100 feet, collected as a pupa from a cement animal-watering trough by a well just outside the city walls. *Paratypes:* Five males, 18 females, 1 set associated skins, same data as for holotype (coll. no. 330); 3 females, 1 set associated skins, Wadi Dhahr, 8 miles northwest of San'a, Yemen, February 13, 1951, elevation 7,000 feet, collected as larvae and pupae from a broad open well in which the water level was 15 feet below the surface (coll. no. 331); 18 larval skins (10 slides), 1 set associated skins, Wadi Dhahr, February 11, 1951, collected as larvae from a large cement basin (coll. no. 328); 1 larval skin, Rouda, 3 miles north of San'a, February 15, 1951, elevation 7100 feet, collected from a large cement tank (coll. no. 333).

The holotype and a portion of the paratypes are deposited in the U. S. National Museum. The remainder of the paratypes are in the collections of the British Museum (Natural History) and of the author.

Discussion.—According to the classification of Edwards (1941: 282), this species is a member of the *pipiens* series of Group B (*pipiens* group). Based on both adult and larval characters, it is most closely related to *Culex laticinctus* Edwards. In the adult stage *laticinctus* differs mainly in possessing two or more mesepimeral bristles and in many details of the male genitalia. Two specimens of the new species possess two lower mesepimeral bristles on one side but none were observed with this number occurring on both sides. The larva of *laticinctus* differs from that of the new species in that the antenna is not uniformly colored, the mentum has only 7–8 lateral teeth on a side, the dorsal surface of the siphon is straight from near the base when seen in lateral view, the pecten teeth are of quite a different form; the upper caudal seta (hair 2 or *isc*) has four or more branches, the anal gills are shorter than the anal plate, and the ventral brush usually has 14 hair tufts.

Since the only specimens of *laticinctus* collected by me in the Yemen were from Ta'izz, a locality which lies at the much lower elevation of 4,100 feet, it seemed quite reasonable to assume that the record of *laticinctus* from San'a given by Edwards (1941: 314) actually refers to this species. Upon request Mr. Mattingly of the British Museum kindly checked these specimens and found them indeed to be *mattinglyi*.

In Edwards's (1941: 284) key to the Ethiopian species of the subgenus *Culex*, this species goes to *ninagongoensis* Edwards and *calurus* Edwards (couplet 35). However, it differs markedly from them on the basis of male genitalia. Also, the larva of *ninagongoensis* is strikingly different in that the comb is entirely composed of spines. The larva of *calurus* is unknown.

In the larval key of Hopkins (1952: 246) this species will not completely pass the second bracket in that, like *C.* (*Neoculex*) *stellatus* van

Someren, it has the thoracic integument rather densely spiculated.

It is believed that the unusual development of the dististyle alone adequately distinguishes this new species from all other known Ethiopian *Culex*.

This species is dedicated to P. F. Mattingly, Department of Entomology, British Museum (Natural History), who has contributed so much to the modern taxonomy of mosquitoes and who has so generously and unceasingly made available his time for the help of others.

Culex (**Neoculex**) **jenkinsi,** n. sp.

Adult.—A rather small species with sparsely haired male palpi, pale yellowish scutal scales, postspiracular and prealar scales, and apical pale abdominal bands.

MALE: Wing length approximately 3.5 mm. *Head:* Proboscis dark, apical portion darker than the remainder. Palpus longer than the proboscis by nearly the length of segment V; dark; a few short hairs arising apically on III, along IV, and basally on V. Vertex with narrow white scales dorsally and broad white scales laterally; up-

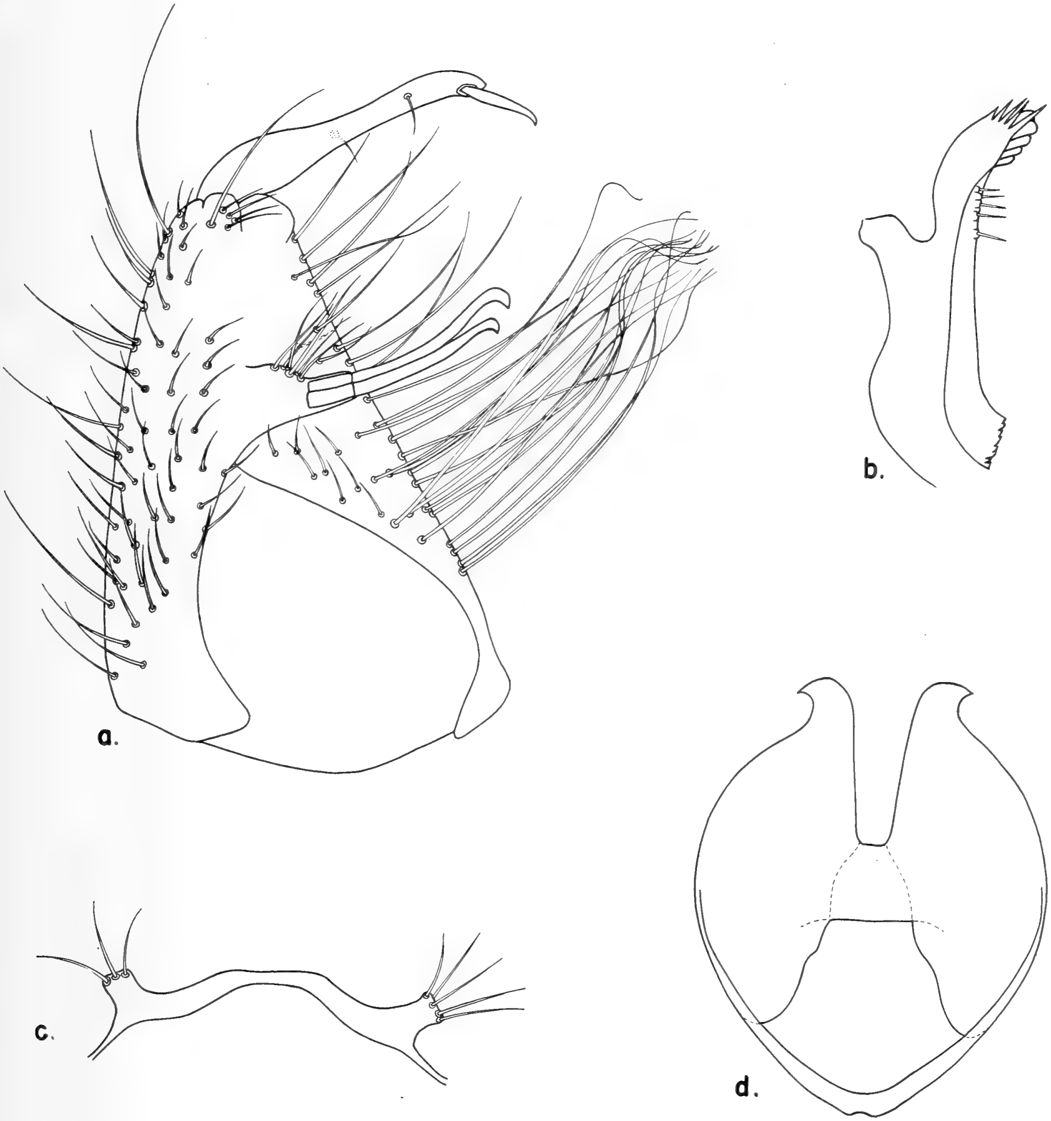

FIG. 2.—*Culex* (*Neoculex*) *jenkinsi*. Male genitalia: *a*, Mesal aspect of right basistyle; *b*, lateral aspect of paraproct; *c*, ninth tergite; *d*, sternal aspect of mesosome.

right-forked scales pale brownish in color, somewhat darker laterally. *Thorax:* Scutum with pale yellowish narrow scales, the scales paler in color around the margins and on the prescutellar space. Scutellar scales narrow, pale. *Apn* with a few broadened pale scales; *ppn* usually with some narrow white scales. Pleural integument brownish, without obvious markings. Each of the following pleural areas with a patch of broadened whitish scales: propleural (very few), postspiracular (very few), prealar knob (very few, on lower portion of knob), dorsal sternopleural, medioposterior sternopleural, dorsal mesepimeral (confluent with hair tuft), and medial mesepimeral. Prosternum without scales. One lower mesepimeral bristle present (one specimen with two bristles present on either side). *Legs:* Coxae each with an anterior patch of white scales. Fore and mid femora anteriorly dark except for an apical line of pale scales; hind femur pale, a dorsal dark line from near base that apically widens across the anterior surface, an apical line of pale scales. Tibiae dark except for apices. Tarsi dark. Fore and mid tarsal claws unequal, each unidentate; hind equal, simple (from slide mount). *Wings:* Dark-scaled. Upper fork cell approximately 2.2–2.5 times longer than its stem. Cross veins separated by somewhat more than twice the length of posterior one. *Abdomen:* Tergites II-VII with distinct apical pale bands. Sternites pale-scaled, baso-lateral dark scaling usually present on the more apical segments. *Genitalia* (fig. 2): Tergal surface of basistyle bearing a distinctive clump of long apically-twisted setae; subapical lobe with two stout rods (probably *a* and *b*) and about 5–6 short setae. Dististyle enlarged basally. Paraprocts with a subapical lobe. Phallosome with lateral plates smooth. Lateral lobes of ninth tergite prominent, each bearing from 3–7 prominent setae; no prominent median lobe.

FEMALE: Wing length approximately 3.9–4.4 mm. Differing from the male as follows: Palpi approximately one-fourth the length of the proboscis, dark. Torus and first flagellar segments with white scales. Propleural and postspiracular areas with more scales than in male. Upper fork cell approximately 2.8 times longer than its stem. Tarsal claws equal, simple (slide mount).

Larva.—Not known.

Types: Holotype. Male (coll. no. 308), genitalia mounted on a slide, U.S.N.M. no. *61659*, El-Hauban, Wadi el-Malah, about 3 miles east of Ta'izz, Yemen, January 16, 1951, elevation about 3,700 feet, collected as larvae from emergent vegetation in the quiet marginal water of a drying wadi stream. *Paratypes:* Two males, 5 females, same data as for holotype (coll. no. 308); 1 male, 1 female, Wadi Mal el-Ghail, about 14 miles west of Ma'bar, Yemen, February 7, 1951, elevation about 6,500 feet, collected as larvae from pools along small stream flowing from mountain spring (filamentous green algae present) (coll. no. 325).

The holotype and a portion of the paratypes are deposited in the U. S. National Museum. The remainder of the paratypes are in the collections of the British Museum (Natural History) and of the author.

Discussion.—Based on the classification of Edwards (1941: 249), this new species is a member of Group B (*Neoculex* s. str.). In the Ethiopian region Group B includes the following species: *peringueyi* Edwards, *seyrigi* Edwards, *salisburiensis* Theobald, *andreanus* Edwards, *kingianus* Edwards, *kilara* Van Someren, and *rubinotus* Theobald. *Culex coursi* Doucet, 1949, described from the larva from Madagascar, may belong here since the larva resembles that of *salisburiensis*.

In Edwards's key (1941: 253) to the Ethiopian species of *Neoculex*, this species keys to *seyrigi* (female unknown). The adult is similar to the description of *seyrigi* by Edwards (1941: 256) except that the scales of *ppn* are mostly narrow, no mention is made of the dorsal mesepimeral patch, and all of the tibiae have pale apices. The male genitalia differ in having the dististyle humped sub-basally instead of straight and tapering, the two bristles on the dististyle are not as near to one another as shown by Edwards (1941: fig. 82b), the ninth tergite is not as strongly lobed medially and the lateral lobes have 3–7 bristles each instead of 8–10, and the tips of the lateral plates of the mesosome are not tuberculate.

The larva of *seyrigi* is unknown but possibly *coursi* Doucet (Madagascar) is the larva of this species (Hopkins, 1952: 253). *C. seyrigi* is known only from Madagascar.

Although distinct, this species shows a close relationship to published descriptions of Mediterranean material of *Culex* (*Neoculex*) *apicalis* Adams. A re-evaluation of European *apicalis* has been made by P. F. Mattingly and is to be published soon. The exact relationships of the new species described here will be elaborated in that paper.

This species is dedicated to Dr. Dale W. Jenkins, Medical Division, Army Chemical Center, Maryland, who has contributed so materially to our knowledge of medically important insects.

LITERATURE CITED

Belkin, J. N. *A revised nomenclature for the chaetotaxy of the mosquito larva (Diptera: Culicidae)*. Amer. Midl. Nat. **44**(3): 678–698, 1950.

Edwards, F. W. *Mosquitoes of the Ethiopian Region. III. Culicine adults and pupae*, 499 pp. British Museum (Natural History), London, 1941.

Hopkins, G. H. E. *Mosquitoes of the Ethiopian Region. I. Larval bionomics of mosquitoes and taxonomy of culicine larvae*, ed. 2, 355 pp. British Museum (Natural History), London, 1952.

ENTOMOLOGY.—*Recent advances in the taxonomy and distribution of* Grylloblatta (*Orthoptera: Grylloblattidae*). Ashley B. Gurney,[1] U. S. Bureau of Entomology and Plant Quarantine.

This paper summarizes the important developments regarding the genus *Grylloblatta* which have come to my attention during the past five years. In 1948 I brought together the principal taxonomic and distributional data on these unusual insects (Gurney, 1948) and it is a tribute to the zeal of numerous diligent collectors that several extensions of the generic distribution have recently been made, and at least two new species have been found. Best of all, both sexes of the two new species here described are known, and the great importance of the male terminalia as specific characters is now evident. The contents of the alimentary canal have been removed from specimens of three species (*rothi*, *bifratrilecta*, *sculleni*), and notes on the results of the examination appear in the discussion of those species. Annotations are included on several important papers which have appeared since my 1948 catalogue was written. Special interest is attached to a related new genus from Siberia described by Bei-Bienko (1951), whose paper has been translated by Miss Ruth Ericson, of the Bureau of Entomology and Plant Quarantine.

KEY TO SPECIES OF GRYLLOBLATTA

1. Dorsal valve of ovipositor reaching to middle of cercus, or at least to apical half of fifth segment; antenna of adult composed of 36 segments or less, of nymph not over 30....2

   Dorsal valve of ovipositor not reaching to middle of cercus, or beyond base of fifth segment; antenna of adult often composed of 39 or more segments, of nearly mature nymph usually more than 30 (northern California, Oregon)....................................5

2. Apical half of male supra-anal plate symmetrical or nearly so (Fig. 3) (Washington to Montana and northward)......................3

   Apical half of male supra-anal plate asymmetrical (Figs. 4, 5) (Oregon, California)..4

3. Stylus of male about three times as long as wide (Fig. 8); antenna of adult with an average of less than 30 segments (Alberta, British Columbia, Montana)
   campodeiformis campodeiformis Walker

   Stylus of male about four times as long as wide (Fig. 8a); antenna of adult with an average of more than 30 segments (Washington, British Columbia)
   campodeiformis occidentalis Silvestri

4. Stylus of male attached laterally (Fig. 6); male supra-anal plate with left apical corner conspicuously developed, lobelike (Fig. 5); segments of cerci comparatively short (Figs. 14, 16) (Oregon)..............*rothi*, n. sp.

   Stylus of male attached basally (Fig. 7); male supra-anal plate with left apical corner angular rather than lobelike (Fig. 4); segments of cerci comparatively elongate and slender, especially the more apical ones (Fig. 15) (California).............*bifratrilecta*, n. sp.

5. (Adult unknown), antenna of nymph composed of 36–40 segments; compound eye prominent, proportion of greatest length of eye to width

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[1] The cooperation of the following persons, who have assisted by making specimens and notes available, is gratefully acknowledged: Henry K. Townes, North Carolina State College; Vincent D. Roth, Oregon State College; J. W. MacSwain, E. G. Linsley, and Paul D. Hurd, Jr., University of California (Berkeley); E. Philip Pister, U. S. Fish and Wildlife Service, Berkeley, Calif.; Harry P. Chandler, California Division of Fish and Game; John A. Chapman, Montana State University; and W. L. Nutting, Harvard University. Thanks are also given to the following University of California students who made a special and highly successful attempt to find *Grylloblatta* at Sonora Pass, Calif., while engaged in summer field activities with Dr. MacSwain: O. R. Ali, C. A. Downing, J. J. Drea, S. M. Kappos, S. Katana, J. L. Mallars, and B. Puttler. For several days these men worked very hard at a task which was difficult and sometimes dangerous, and as a result the specimens of *bifratrilecta* are more numerous and complete than the original series of any previously described species of Grylloblattidae.

of head about as 1:4.4; color of body grayish brown (northern California) *barberi* Caudell

Antenna of nymph normally containing 31–32 segments; compound eye distinctly smaller than above, proportion of greatest length of eye to width of head about as 1:5.8; color of body light amber, paler than in *barberi* (Oregon) . . . . *sculleni* Gurney

Grylloblatta rothi, n.sp.

Figs. 1, 5, 6, 10–12, 14, 16

Male (holotype): Size small for genus; body clothed with fine pubescence; major body setae less conspicuous than usual for genus. Antennae with 29 segments (left), 19 (right, broken); compound eye large (Fig. 1), longer with respect to head size than in *C. campodeiformis*; pronotum with lateral margins noticeably converging posteriorly, more so than in holotype of *sculleni*; legs comparatively short and stout; leg ratios (length divided by width) as follows: front femur, 2.8; hind femur, 4.8; front tibia, 5; hind tibia, 9.

Supra-anal plate borne asymmetrically, so that base of left cercus is posterior to right cercus (Fig. 5); plate with highly distinctive lobelike development of left posterior apical corner; left coxite more elongate than in *c. campodeiformis*, oblique mesal margin decidedly rounded rather than nearly straight as in latter, pubescent but lacking distinctive major setae; right coxite with usual pubescence, but lacking strong lateral setae such as those of *bifratrilecta*; left and right styli each borne laterally on basal half (Fig. 6); phallic sclerites of same pattern as in *campodeiformis*, but differing in details; main phallic sclerite with dorsolateral lobe (Fig. 10, *dll*) about half as long as lateral margin below the dorsal cap, unlike much shorter lobe in *campodeiformis*; ventrolateral lobe (*vll*) not as produced as in *c. campodeiformis*; apical lobe of accessory sclerite of right phallomere (Fig. 12) rounded and lobelike, less elongate and tapering than in *c. campodeiformis* (Fig. 13). Cerci without dark major setae such as occur in other species, though pale delicate counterparts appear to occur amid pubescence; segments relatively short, basal segments as in female (Fig. 16), terminal segments (Fig. 14) much shorter than usual for genus.

Coloration: General coloration very pale, much of body antimony yellow (Ridgway), grading to dark yellow ocher (Ridgway) on dorsal surface of abdomen and the posterior half ventrally; antennae, legs, coxites, and cerci lighter (warm buff, Ridgway); eyes black.

Measurements (lengths in millimeters): Body, 14.5; antenna, 8; eye, 0.53; pronotum, 2.35; hind femur, 3.3; hind tibia, 3.2; cercus, 3.4; width of head, 2.4; of pronotum, 2.18; of hind femur, 0.7.

Female (allotype) (specimen relaxed and transferred to alcohol after being dry on a pin): Differing from male in somewhat larger size, proportionately more slender hind tibia, much darker color (possibly due to method of preservation), and the usual sexual features. Antennae with 23 segments (left, broken), 29 (right); leg ratios (length divided by width) as follows: front femur 3, hind femur 4.9, front tibia 5.7; hind tibia 11.

Abdominal appendages (Fig. 16) with three terminal segments of cerci missing, dorsal valve of ovipositor apparently reaching to segment seven, with weakly developed setae on basal half; several transverse fracture lines on middle and lower valves (apparently due to breakage).

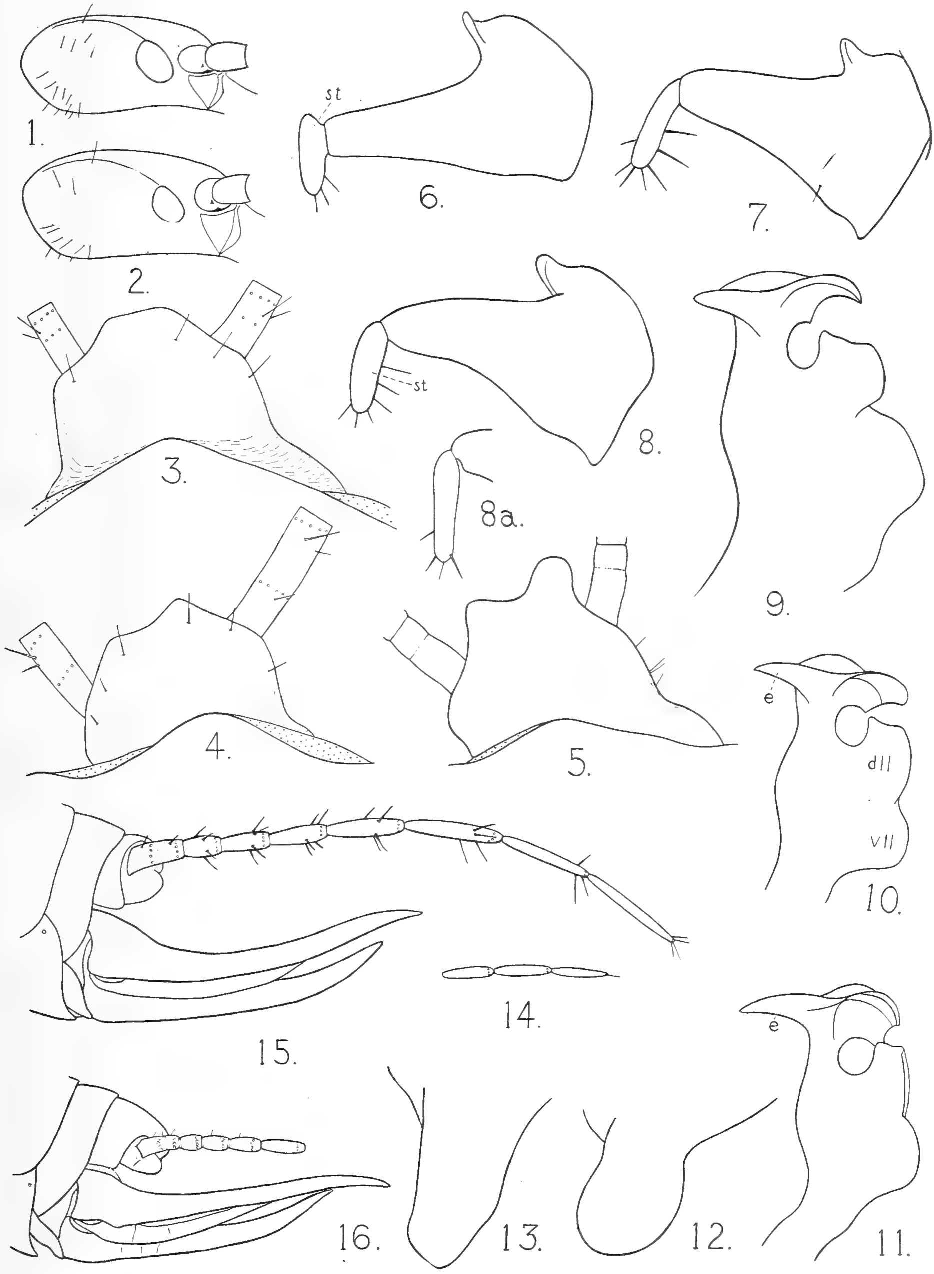
Coloration: General body color brown, legs, abdomen and its appendages paler and about cinnamon; antennae prout's brown (Ridgway), with some irregular paler areas.

Measurements (lengths in millimeters): Body,

Figs. 1–16.—1, *Grylloblatta rothi*, male holotype, lateral view of head; 2, *G. campodeiformis campodeiformis*, male from Gallatin County, Mont., lateral view of head; 3, Same specimen as Fig. 2, dorsal view of supra-anal plate; 4, *G. bifratrilecta*, male holotype, dorsal view of supra-anal plate; 5, *G. rothi*, male holotype, dorsal view of supra-anal plate; 6, *G. rothi*, holotype, lateral view of right coxite and stylus; 7, *G. bifratrilecta*, holotype, lateral view of right coxite and stylus; 8, *G. c. campodeiformis*, male specimen from Gallatin County, Mont., lateral view of right coxite and stylus; 8a, *G. c. occidentalis*, male topotype from Mount Baker, Wash., lateral view of apex of right coxite and stylus; 9, *G. c. campodeiformis*, male specimen from Gallatin County, Mont., oblique view of main phallic sclerite; 10, *G. rothi*, holotype, oblique view of main phallic sclerite; 11, *G. rothi*, holotype, lateral view of main phallic sclerite; 12, *G. rothi*, holotype, apical lobe of right phallomere; 13, *G. c. campodeiformis*, Gallatin County, Mont., apical lobe of right phallomere; 14, *G. rothi*, holotype, terminal three segments of cercus; 15, *G. bifratrilecta*, female allotype, terminal structures of abdomen; 16, *G. rothi*, female allotype, terminal structures of abdomen, (three terminal segments of cerci missing) same scale as Fig. 14. (dll-dorsolateral lobe of main phallic sclerite; e—apex of copulatory process; st—stylus; vll—ventrolateral lobe of main phallic sclerite.)

16; antenna, 9; eye, 0.5; pronotum, 2.5; hind femur, 3.4; hind tibia, 3.4; width of head, 2.4; of pronotum, 2.2; of hind femur, 0.7; of hind tibia, 0.31.

Type.—U.S.N.M. no. 61656. A male from Happy Valley, on Century Drive about 15 to 20 miles south of Sisters, Oreg. Altitude, 6,450 feet, about 2,000 feet below lowest snowfields. Collected September 12, 1948, by Vincent D. Roth. Found in the center of a rotten log about 2½ to 3 feet in diameter while Mr. Roth was collecting spiders. "The wood was almost completely decayed and it was fairly damp in the center. The area around was typical for the



FIGS. 1–16.—(See opposite page for legend).

country, small pine with not too much undergrowth. There was a stream about 100 feet away and a meadow about the same distance" (V.D.R.). Mr. Roth also wrote that the specimen was exposed to the sun but moved slowly. Then it was placed in a vial with some damp organic matter, and when removed from his pocket a few minutes later it had died. Fragments of unidentifiable insect material were in the digestive tract.

Allotype.— A specimen in the U. S. National Museum, one of two females reported by Elsea (1937). They were found beneath a stone at 6,500 feet altitude at Crater Lake, Oreg., on November 27, 1936. The location of Elsea's second specimen is unknown. Crater Lake is approximately 90 miles south of Happy Valley, and both localities are situated along the eastern margin of the Cascade Mountains.

The shortness of the cercal segments separates *rothi* from all other species except possibly *barberi*, and the character is so distinctive that the association of sexes is believed correct. Judged by nearly mature nymphs, which appear to give a satisfactory indication, *barberi* has a much larger number of antennal segments than *rothi*. The latter is the first of the genus to be found with a highly asymmetrical male supra-anal plate. The type locality of *rothi*, Happy Valley, is only some 20 miles southeast of McKenzie Pass where *sculleni* occurs, but the nature of the cerci leaves no doubt regarding the distinctness of the two species, though the male of *sculleni* is still unknown.

It is a pleasure to name this new species for Vincent D. Roth, who for several years has shown a remarkable and persistent interest in collecting *Grylloblatta*.

Grylloblatta bifratrilecta,[2] n. sp.

Figs. 4, 7, 15

Male (holotype): Size medium for genus; fine body pubescence and major setae moderately conspicuous, more so than in *rothi*; antennae with 28 segments (left), 30 (right); compound eye proportionately smaller than in *rothi*, about as in *c. campodeiformis*; pronotum with lateral margins moderately converging posteriorly; legs much as in *c. campodeiformis*, ratios (length divided by width) as follows: front femur, 3.1; hind femur, 5.7; front tibia, 6.2; hind tibia, 10.8.

Supra-anal plate borne asymmetrically; plate with apical half moderately asymmetrical, with apical corners angular, the left corner more produced than the right (Fig. 4); left coxite with mesal margin broadly rounded, unlike *c. campodeiformis*, but less produced than in *rothi*, a major seta on disc of coxite slightly laterad of and a little posterior of the middle, another major seta near mesal margin at about middle; right coxite (Fig. 7) with two major setae; styli each borne basally, more elongate than in *c. campodeiformis*; main phallic sclerite with apical lip of copulatory process (*e*) stouter in lateral view than in *rothi*, dorsolateral and ventrolateral lobes much as in *rothi*; apical lobe of accessory sclerite of right phallomere differing from *rothi* in having the lateral margins nearly parallel.

Measurements (lengths in millimeters): Body, 20; antenna, 12.5; eye, 0.5; pronotum, 2.8; hind femur, 4; hind tibia, 4.3; cercus, 5.9; width of head, 2.7; of pronotum, 2.45; of hind femur, 0.7; of hind tibia, 0.4.

Coloration: Body mainly ochraceous buff (Ridgway); the terga slightly darker than sterna; coxites, cerci, and tarsi paler; head and antennae darkened to zinc orange (Ridgway), latter paler in apical third; eyes black.

Female (allotype): Differing from male in somewhat more robust body and slightly more elongate legs, in addition to usual sexual characters. Antennae with 31 segments (left), 30 (right); leg ratios (length divided by width) as follows: front femur, 3.1; hind femur, 6.6; front tibia, 6.4; hind tibia, 12.3.

Abdominal appendages (Fig. 15) with short, stout setae well represented on basal half of dorsal valves and basal half and ventral margin of ventral valve; dorsal valve reaching to segment 6 of cercus; major setae of cercus conspicuously developed.

Coloration: As in male.

Measurements (lengths in millimeters): Body (rather contracted), 17; antenna, 12.5; eye, 0.5; pronotum, 3.1; hind femur, 4.6; hind tibia, 4.9; cercus, 6; width of head, 3.1; of pronotum, 2.7; of hind femur, 0.7; of hind tibia, 0.4.

Type.—U.S.N.M. no. 61132. Male from Sonora Pass, Calif., elevation 9,000 to 10,000 feet, collected July 20, 1951, by J. W. MacSwain. (Sonora Pass is on California Highway 108 about 50 miles southeast of Lake Tahoe and about 10 to 15 miles north of the northern boundary of Yosemite National Park.)

Allotype.—U.S.N.M. Female from two miles

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[2] Meaning "collected by two brothers," with reference to Henry K. and George Townes.

west of Sonora Pass, Calif., elevation about 8,600 feet, collected by Henry K. Townes and George Townes, July 7, 1948.

There are 13 paratypic adults, 12 females and 1 male. Five rather large and 25 small nymphs are not considered paratypes. All are from Sonora Pass, though differing in exact spot, elevation, date, and collector. In addition to the allotype, the Townes brothers collected one adult female and 12 nymphs on July 4, 1948, and 7 females and 9 nymphs on July 7, 1948. Dr. MacSwain collected one nearly mature female on August 4, 1948, and the remainder of the series was taken by him or his associates in 1951, as follows: June 27, three nymphs; July 11, one male, two females, four nymphs; July 13, one nymph; July 20, two females. In addition to the U. S. National Museum, paratypes will be deposited at the following institutions: Academy of Natural Sciences of Philadelphia; Museum of Zoology, University of Michigan; University of California; California Academy of Sciences.

The body length of the male paratype is 19 mm, pronotal length 2.7 mm. Female paratypes vary in body length from 17 to 20 mm, in pronotal length from 2.7 to 3 mm. The antennae of the paratypes which clearly are unbroken (16 antennae) range in the number of segments from 27 to 32, with an average of 30.2. Two paratypes have the ovipositor reaching only to the apical half of the fifth segment of the cercus. Two females and a male taken July 11, 1951, are noticeably redder than the others, being reddish cinnamon-rufous (probably due to some difference in preservation). Other adults are comparable to the type and allotype in color. The nymphs are paler, the smallest one whitish except for the black eyes.

Females of *bifratrilecta* may easily be confused with those of *campodeiformis campodeiformis*, though the leg proportions are slightly different. The front tibia of *c. campodeiformis* is proportionally stouter, with the several pairs of spine-like setae along the ventral margins closer to each other than in *bifratrilecta*. The terminal segments of the cercus of *bifratrilecta* are less elongate than those of *sculleni*.

The Townes specimens were found on the north-facing slope of the canyon which walls Chipmunk Flat near the main highway that crosses the Sierras at Sonora Pass. The slope includes many cliffs and talus rock slides. The grylloblattids occurred by an isolated patch of snow, about 50 by 20 feet located in a depression. The majority of specimens were taken near one side of the snow patch, where both large rocks and gravel occurred. Small nymphs were fairly common in the wet gravel, but large nymphs and adults were mainly under the larger rocks. The zone from about a foot away from the snow to about 4 inches in from the margin beneath it was preferred habitat. The Towneses also observed a good deal of decaying organic material—including a few patches of dead grass and blown pine needles, and they found that Collembola, centipedes and millipedes were common.

Dr. MacSwain's 1948 nymph was found just below the 9,000-foot level under the retreating margin of a snow field on a north-facing slope. Specimens taken in June 1951 were at about 10,500 feet and either were at the margin of snow or under large rocks protruding through or near the snow. Other 1951 collections were made in several situations. Several specimens were under large rocks on either side of a stream running beneath a snow field. By digging away the loose rock and soil, Dr. MacSwain observed but was unable to capture two nymphs under a large boulder. This boulder was easily 15 feet from a large snowfield.

A night collecting trip was made July 20. Four students (Katana, Kappos, Puttler, and Downing) accompanied Dr. MacSwain to the 9,000 foot level by car, from where they climbed before dark to the base of some high cliffs. Just before darkness, which fell at 8:30 p.m. (daylight saving time), one female and two nymphs were found in a rocky crevice in the cliffs. They occurred under rocks on the moist side of the crevice a distance of several feet from snow and running water. Insect fragments found near the female suggested that she may have been feeding. After dark various patches of snow were examined and three adults were taken separately, one under the margin of a snow field, and two moving over the surface above. The holotype was taken at 10 p.m. running over the snow about 18 inches from the margin of a large snowfield. All the other specimens were either more closely associated with the retreating margins of snow patches or with places from which snow had disappeared. The temperature was warm enough so that sweaters were not needed and the moon was full but the sky overcast.

An adult female collected July 20, 1951, had many fragments of insects in the digestive tract, especially broken sclerites and parts of legs. Pieces of an ovipositor and of a wing from a small hymenopteron, possibly a braconid, were recognized. Three other adults yielded fragments of a spider, of beetles, and the scales of a moth. In two small nymphs, 8 and 9 mm long, respectively, were found fragments of a tiny beetle, possibly one of the Pselaphidae, and of a spider. Dr. MacSwain informed me that specimens kept alive in a refrigerator at a constant temperature of 8°C. were fed freshly collected moths which were first immobilized by pinching. These specimens have been noted briefly by MacSwain (Pan-Pac. Ent. **29**: 62. 1953).

An attempt to induce matings in captivity was abandoned by Dr. MacSwain because the male and female concerned tried to chew each other and had to be separated to prevent injury.

Grylloblatta spp.

What may prove to be an undescribed form of *Grylloblatta* occurs in Mono County, Calif., near the Mammoth Crest. Available material consists of a single adult female collected July 8, 1950, by Norman Reimers, a University of California student then engaged in making a biological survey for the U. S. Fish and Wildlife Service. The specimen was found at an altitude of about 12,000 feet, at the base of a snowfield adjacent to a small pool in which water temperature was about 36°F. The pool is near Lake Dorothy in the Upper Convict Basin. On the Mount Morrison Quadrangle of the U. S. Geological Survey topographic maps of the area, the pool is adjacent to a tiny lake southwest of Lake Dorothy on a direct line between Lake Dorothy and Lake Virginia, and about three-fourths of the distance from Lake Dorothy to the county line between Mono and Fresno Counties.

The specimen is much like *bifratrilecta* in general appearance, but the femora are more slender than in Sonora Pass females. There are 34 (right) and 33 (left) antennal segments, respectively, which is slightly more than have been found in *bifratrilecta*. Until more material is available, preferably including a male, it is desirable to postpone any definite judgment regarding the status of this population.

The Mammoth Crest is located in the area of the Mammoth Lakes and Devil's Postpile National Monument, and it forms an offshoot from what is considered the main crest of the Sierra Nevada Range. It is about 70 miles southeast of Sonora Pass, suggesting that the distance and more especially the location rather apart from the main Sierra Nevada Range may have contributed to the development of a form at least subspecifically distinct from *bifratrilecta*.

Thanks to Harry P. Chandler, of Red Bluff, Calif., I have learned that he and his associates have collected *Grylloblatta* at several localities in the area surrounding Mount Lassen, and it is to be expected that they will publish on their discovery. It would naturally be suspected that the population might represent *G. barberi* Caudell, the type locality of which is some 25 miles or more south of Mount Lassen.[3] Unfortunately, the type series of *barberi* consists of nymphs only, though several specimens are nearly mature. Through Mr. Chandler's kind cooperation, I have examined some of the new material, including both male and female, but I am uncertain whether the specimens represent *barberi*. The discovery of a mature male at the type locality of *barberi* is highly important to a thorough comparison and resulting sound decision regarding the identity of populations in northern California.

Grylloblatta sculleni Gurney

Grylloblatta sculleni Gurney, Pan-Pac. Ent. **13**: 164, figs. 7–11. 1937. Type locality by original designation: Scott Camp (6,600 feet altitude), Three Sisters, Cascade Mountains, Oreg.

One adult female and 48 nymphs, collected at the type locality October 11–12, 1952, by Vincent D. Roth, have been examined. The adult is much paler than the holotype. The ovipositor extends to the base of the fifth segment of the cercus, slightly longer than in the holotype, and both specimens have 39 segments in the right antenna and 32 in the apparently unbroken left antenna. Regardless of the contraction or extension of the terminal terga, which accounts for some difference in the respective positions of the ovipositor and cerci, the cerci of *sculleni* proportionally are distinctly longer than those of *bifratrilecta*. The nymphs here recorded include numerous specimens of both sexes. The antennae of two pairs of nymphs ranging from 13 to 15 mm in body length have 35 to 38 segments. The smallest nymph is 4 mm long.

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[3] The type locality of *barberi* is about 20 miles southwest of Westwood, Calif., near an entrance of the Sunnyside Mine, on the North Fork of the Feather River just above the junction of Butte Creek and about 3 miles below Seneca.

The type locality consists of talus slopes which terminate a small valley a hundred yards wide and a few hundred yards long just above the Sunshine Shelter on the slope between the North and Middle Sister. The valley faces south and the talus slopes are mainly on the westerly part and present a very rocky path to the treeless sides of the Middle Sister.

Mr. Roth writes regarding his collection: "The majority of the specimens were obtained from under rocks within 1½ feet from the snow and ice, and one specimen was collected on the snow under a large rock. The microhabitat most suitable for the insects seemed to be one which was damp but not wet, cold but not freezing, and where there were loose rocks and some soil. At the base of one talus slope where the rocks were partly silted in, no specimens were found. Since the grylloblattids are considered to have nocturnal habits, I visited the talus slope from which I collected most of the specimens about 7 p.m., after the sun had disappeared. Only one specimen was seen during a half hour searching and that was on a rock about 4 inches from the snow."

Several arthropods were found by Mr. Roth in the same environment with *sculleni*, either on or beneath rocks at the snowline. A fungus gnat which occurred in fairly large numbers on the rocks and which did not seem inclined to fly, has been identified by Alan Stone as a new species of *Boletina* (Fungivoridae), a staphylinid by M. H. Hatch as *Phloepterus* sp., and a centipede by R. V. Chamberlin as *Linatenia chionophila* (Wood), "a characteristically northern form, widespread across Canada and the northern United States." M. C. Lane identified an elaterid larva as *Hypolithus nocturnus* (Esch.), and Clarence J. Goodnight identified two phalangids as *Sabacon crassipalpe* (L. Koch) and referred to them as a circumboreal form often found in cold areas.

A nymph 8 mm long had many insect fragments in the digestive tract, including pieces appearing to be from the wing of a fly, and the antenna apparently from a tiny beetle. It seems quite possible that *Boletina* sometimes serves as food for *G. sculleni* in this locality.

Grylloblatta campodeiformis campodeiformis Walker

Figs. 2, 3, 8, 9, 13

Grylloblatta campodeiformis Walker, Can. Ent. **46**: 93–99, figs. 1–7. 1914. Type locality by original designation: Sulphur Mountain, near Banff, Alberta.

New distribution records: Missoula, Missoula County, Mont., 3,700 feet, February 11, 1950 (1 female); same, about 3,500 feet, April 12, 1953 (1 male, 1 female), (taken separately under surface rocks at base of rock slide, temperature 34°F.); Mission Mountains, Lake County, Mont., 7,500 to 10,000 feet, September 14, 19, 20, 1952 (1 female, 9 nymphs); vicinity of Holland Lookout, Swan Valley, Lake County, Mont., at summit and localities between there and three miles to the north, elevations from about 6,500 feet to 10,400 feet at summit, October 4, 1952 (5 males, 7 females, 14 nymphs). All collections were made by John A. Chapman, of the Department of Zoology, Montana State University.

Previous Montana records have been summarized and the localities shown on a sketch map (Gurney, 1948, pp. 90–91). Until now, Montana records from west of the Gallatin Canyon have been limited to one large male nymph taken on the snow January 26, 1947 by W. L. Jellison along the East Fork Road, 10 miles east of Sula, Ravalli County. Three counties in a vertical tier along the Rocky Mountains of western Montana are now represented. The widespread character of the distribution is shown by the individual localities in the Mission Mountains area at which Mr. Chapman found specimens, as follows: McDonald Peak, about 10,000 feet; North Branch of the Mission Basin, about 8,000 feet; in the Duncan Lake Drainage, about 7,500 feet. Mr. Chapman found an adult female beneath a board in the yard of his home near Missoula on April 12, 1953. The 16 adults here recorded have a total of 24 unbroken antennae which range in number of segments from 26 to 29 (average, 28.5). As many as 30 segments appear to be uncommon in *c. campodeiformis.*

ANNOTATED LIST OF REFERENCES

1. BEI-BIENKO, G. IA. *A new representative of orthopteroid insects of the group Grylloblattoidea (Orthoptera) in the fauna of the USSR.* Ent. Obozr. **31** (3–4): 506–509, 4 figs. 1951. (In Russian.)

Grylloblattina djakonovi, n. gen., n. sp., described from a single female found Sept. 20, 1934, by A. M. Djakonov in a rotting tree stump in woods at [? Island] of Petrov in the [? bay] of Siaukh near the mouth of the river Sudzukh, southern Maritime Provinces [of Siberia]. (The locality, ascertained through the cooperation of consultants in the Slavic Room of the Library of Congress, is approximately 90 miles east of Vladivostock, at latitude 42° 52′ N. This first locality for the Grylloblattidae

from the Asiatic mainland is about 200 miles farther north than localities in northern Honshu at which *Galloisiana* has been taken, but some 400 miles south of British Columbian habitats of *Grylloblatta*. The genus is most closely related to *Galloisiana* and is especially distinguished by 5-segmented cerci, the apical segment of which is specialized. The latter is widened toward the apex, but is conically and strongly narrowed and finally is cylindrical to the apex.—A.B.G.)

2. Campbell, Matthew G. *Notes on* Grylloblatta *at Kamloops*. Proc. Ent. Soc. British Columbia **45**: 1–5. 1949. Presented posthumously, with editorial notes by G. J. Spencer.

Detailed notes from the personal observations of an amateur entomologist who collected numerous specimens at Kamloops, B. C., and maintained cultures in the basement of his home. The conditions of the natural habitat and those of the culture containers are carefully explained. It is suggested that in cultures soft rotted humus among loose stones is a good medium, with temperatures between 30 and 40° F. It is emphasized that the Kamloops population can survive higher temperatures than the one in Alberta (typical *campodeiformis*), and that exposure to 26° F. is fatal. (It is important that the taxonomic status of the Kamloops population be re-examined by carefully comparing Kamloops males, when available, with those of *G. c. occidentalis*.—A.B.G.)

3. Chopard, Lucien. *Notoptères*, pp. 587–593, figs. 232–235. *In* Traité de Zoologie **9**: 1117 pp. 1949. Edited by Pierre P. Grassé.

A brief summary in keeping with the reviews of other groups in this basic French text and reference book. No original data apparently. One of the best summaries to be found in a general book.

4. Edwards, George A., and Nutting, William L. *The influence of temperature upon the respiration and heart activity of* Thermobia *and* Grylloblatta. Psyche **57**: 33–44. 1950.

The oxygen consumption, heart rate, and activity at various temperatures were determined, in the case of *Grylloblatta* based on specimens from Montana. "*Grylloblatta* is normally active from −2.5 to 11.3 degrees C. At lower temperatures activity is decreased and at higher temperatures activity is increased until at 18 degrees the animals become stuporous and at 20.5 degrees become irreversibly damaged by heat." These insects are "strictly poikilothermal in that they make no metabolic adaptations to offset unfavorable temperatures."

5. Elsea, J. E. *A new locality for* Grylloblatta. Pan-Pacific Ent. **13**: 57. 1937.
6. Gurney, Ashley B. *The taxonomy and distribution of the Grylloblattidae*. Proc. Ent. Soc. Washington **50**: 86–102, 11 figs., 4 text-figs. 1948.
7. Judd, W. W. *A comparative study of the proventriculus of orthopteroid insects with reference to use in taxonomy*. Can. Journ. Res. (sect. D) **26**: 93–161, 98 figs. 1948.

The proventriculus of *Grylloblatta* is compared to that of other orthopteroids. In *Grylloblatta* it is described as of globular shape, with 12 longitudinal folds in the intima and two ranks of 12 pyramidal "teeth" each at its posterior end.

8. Nutting, William L. *A comparative anatomical study of the heart and accessory structures of the orthopteroid insects*. Jour. Morph. **89**: 501–598, 21 pls. 1951.

A valuable, basic study of the heart in all principal groups of orthopteroids. The position of *Grylloblatta* at the base of the saltatorial Orthoptera is strongly suggested. The incurrent-excurrent system in this insect "illustrates the basic ancestral plan from which all of the orthopteroid variations may well have been derived," though the author does not conclude that *Grylloblatta* is *the* ancestral orthopteroid.

9. Pletsch, D. J. *The alpine rock crawler*, Grylloblatta campodeiformis *Walker, in Montana*. Proc. Montana Acad. Sci. **5** and **6**: 17–20. 1947.

Grylloblatta collections made in Montana are reviewed, the first specimen having been found by Fred Skoog in 1936 in the Gallatin Canyon south of Bozeman. Nearly all Montana specimens have been taken in the fall, suggesting that the conditions of spring and summer are unfavorable for *G. campodeiformis* in the portions of rock slides and other habitats that are near the surface. In the extreme northwestern corner of Yellowstone National Park, Wyoming, a single specimen was found in May 1939. An ecology class from Montana State College established a study plot of 119 square yards at 7,500 feet altitude in the Bridger Mountains 20 miles north of Bozeman. It is moderately wooded, with a coarse rock slide on an incline of 20 degrees from the horizontal. The total specimens resulting from one visit during each of five years (October or early November, 1938–42) was 121 (18 adults, 103 nymphs). One specimen occurred at least a foot above ground level in a rotten stump. Rarely does more than one specimen occur under the same stone, and ants and other insects seldom are found with *Grylloblatta*. Adults seldom occur under small stones, though rarely they have been found beneath stones as small as 2 x 3 x 4 inches.

10. Walker, E. M. *On the anatomy of* Grylloblatta campodeiformis *Walker. The organs of digestion*. Can. Journ. Res. (sect. D), **27**: 309–344, 1 pl., 14 figs. 1949.

A detailed description of digestive organs, with special attention to the proventriculus. The latter is much different from that of the Ensifera in that there are 12 longitudinal divisions characterized by flexible, backwardly directed lamellae instead of six divisions armed with columns of complex sclerotized teeth. The Ensifera have the most powerful and elaborate system of hard toothlike structures on the internal lining of the proventriculus of any group of orthopteroid insects. The proventriculus of *Grylloblatta* is believed to serve as a regulatory valve and also possibly as a propulsive organ for the movement of food through the digestive tract. It is concluded that (1) the grylloblattids are the nearest relatives of the Ensifera, but differ too widely to be included within that group, and (2) the saltatorial habit has been independently evolved in the Ensifera and Caelifera.

MAMMALOGY.—*Four new mammals from the Anglo-Egyptian Sudan.* Henry W. Setzer, U. S. National Museum.

Through the efforts and cooperation of the United States Naval Medical Research Unit No. 3 and John S. Owen, formerly district commissioner of Torit District, Equatoria Province, a large collection of mammals has been made available through the Chicago Natural History Museum for study. The specimens, here designated as types, are a part of a larger collection purchased by Harry Hoogstraal from John S. Owen for the Chicago Natural History Museum. The only specimens previously reported from this province were obtained by the Smithsonian Roosevelt African Expedition of 1909–1910 near Nimule and Lado, which were then politically a part of Uganda. The bulk of the present collection was made near Torit and in the Imatong Mountains, both of which lie on the east side of the province. Capitalized color terms are from Ridgway's *Color standards and color nomenclature*. All measurements are in millimeters.

Graphiurus murinus sudanensis, n. subsp.

Type.—Chicago Natural History Museum, no. 79429, adult female, skin and skull, from Torit, Equatoria Province, Anglo-Egyptian Sudan. Obtained December 4, 1951, by J. S. Owen; original number, 2143.

Specimens examined.—Twelve, from Equatoria Province; Torit, 11; Obbo, 1.

Distribution.—Known only from the above localities.

Diagnosis.—Hairs of upper parts with a broad basal plumbeous band, a narrow subterminal band of Clay Color, and then finely tipped with black; color darkest on top of head; hairs of shoulders with a basal plumbeous band and a broad terminal band of Cinnamon-Buff, thus giving the animal a "collared" appearance; black orbital rings conspicuous; cheeks, belly and dorsal surface of hind feet whitish; chest, throat and inside of forelimbs strongly washed with Mikado Brown; tail brownish gray, most hairs white tipped; dorsal surface of hands brownish. Braincase vaulted; width across zygomatic arches greatest at middle; upper toothrows parallel; auditory bullae strongly inflated ventrally; external pterygoid processes widely flaring.

Measurements of type specimen.—Total length 175; length of tail 82; length of hind foot 18; condylobasal length of skull 22.2; greatest zygomatic width 14.6; least interorbital width 4.2; crown length of upper toothrow 3.1; condyloincisive length 23.8; length of nasals 9.6; width of rostrum at level of infraorbital foramen 5.6.

Comparisons.—*Graphiurus murinus sudanensis* differs from *G. m. griseus* from the Isiola River, British East Africa, in that the braincase is less vaulted; the width across the zygomatic arches is greater; the rostrum is wider; the nasals are more rounded anteriorly; the auditory bullae are smaller but more inflated ventrally; the upper toothrows are parallel instead of divergent anteriorly. The color is lighter throughout and the hairs of the tail are white tipped and not concolor.

From *Graphiurus murinus saturatus*, as known from Kaimosi, British East Africa, *G. m. sudanensis* differs in that the bullae appear larger anteroposteriorly but equally inflated ventrally; width across zygomatic arches less, the widest point being, in general, near the middle of the arch and not near the temporal root; the rostrum is narrower; the least interorbital width is generally less. Dorsal color is lighter; the tail is brownish gray instead of brownish; there is more white on the cheeks; and the belly instead of being strongly washed with buff is whitish.

From *Graphiurus parvus parvus* and *G. p. dollmani*, *G. m. sudanensis* differs in being decidedly larger and darker in color.

From *Graphiurus christyi*, as known from Medje, Belgian Congo, *G. m. sudanensis* differs in having the braincase less vaulted; the width across the zygomatic arches less; the rostrum narrower; the nasals not projecting so far posteriorly; the auditory bullae larger and more inflated; the upper toothrows parallel and not diverging anteriorly. The color is lighter; the white markings of the face are present; and the hairs of the belly are more broadly tipped with white.

No specimens of *Graphiurus butleri* are available for comparison, but on the basis of published measurements it appears that *G. m. sudanensis* is smaller; the skull is shorter and narrower; the interorbital constriction is less; the nasals are markedly shorter; and the upper toothrow is shorter.

Specimens of *Graphiurus orobinus* are not available for comparison, but it seems to me that because of its extremely short hind foot this species is in no way related to *G. m. sudanensis.*

From the type of *Graphiurus personatus*, *G. m. sudanensis* differs in being markedly larger and grayer.

Remarks.—Even though actual intergradation cannot be demonstrated with allied races of *Graphiurus murinus*, the majority of the characters of the Sudanese specimens place them in that species. It may well be that as additional specimens are acquired, the species *christyi* and *butleri* will be shown to intergrade with adjacent races of *murinus*.

It is interesting to note that all the specimens except two were taken in native huts. The two exceptions were taken from a tree in the savanna.

Otomys orestes giloensis, n. subsp.

Type.—Chicago Natural History Museum, no. 73901, adult female, skin and skull, from Gilo (long. 32° 50′ 38″ E., lat. 4° 2′ N.), Imatong Mountains, 6,500 feet, Torit District, Equatoria Province, Anglo-Egyptian Sudan. Obtained 10 November 1952 by J. S. Owen; original number, 2278.

Specimens examined.—Nine, all from Gilo.

Distribution.—Known only from the type locality.

Diagnosis.—Over-all coloration of upper parts Olive Brown shading into the plumbeous belly; no sharp line of demarcation between upper parts and belly; plumbeous of belly washed with buff. Tail black above, buffy gray below, the colors not sharply separated. Rostrum of skull relatively long and narrow; nasals not greatly expanded at tip; interorbital region relatively wide; bullae relatively large; upper toothrow relatively long.

Measurements of type specimen.—Length of head and body 161; length of tail 71; length of hind foot 28; length of ear from crown 17; condyloincisive length of skull 34.7; alveolar length of upper toothrow 8.8; length of anterior palatine foramina 6.6; width across zygomatic arches 18.5; least interorbital width 4.6; length of nasals 15.7.

Comparisons.—From the type of *Otomys orestes dollmani*, *O. o. giloensis* differs in darker color, larger body, and longer hind foot. The rostrum is longer and narrower; the nasals less expanded distally; the interorbital region wider; the upper toothrow longer; the auditory bullae larger and more inflated; the width across the zygomatic arches greater; and the wings of the mesopterygoid less flaring.

From *Otomys orestes orestes* as known by specimens from Mount Kenia, British East Africa, *O. o. giloensis* differs in generally darker coloration and somewhat smaller hind feet. The skull differs in wider interorbital region; nasals less flaring anteriorly; anterior palatine foramina shorter; auditory bullae smaller but relatively more inflated ventrally; and upper toothrow shorter.

Remarks.—This new subspecies is well marked both in color and in cranial characters. In morphological characters it is closer to *O. o. dollmani* than to the nominate race. All of the specimens in the type series show the six laminae of M^3, which appear to be typical of the *orestes, irroratus, kempi* section of the *irroratus* group as defined by Ellerman in *The families and genera of living rodents*, vol. 2.

Mus triton imatongensis, n. subsp.

Type.—Chicago Natural History Museum, no. 79535, adult male, skin and skull, from Gilo (long. 32° 50′ 38″ E., lat. 4° 2′ N.), Imatong Mountains, Torit District, Equatoria Province, Anglo-Egyptian Sudan. Obtained January 18, 1952, by J. S. Owen.

Specimens examined.—Twelve, all from Gilo.

Distribution.—Known only from the type locality.

Diagnosis.—Upper parts Warm Sepia in overall tone; hairs finely tipped with Saccardo's Umber; belly, throat, chin, upper lips, and ventral surfaces of forelegs whitish with hairs plumbeous-based and lightly washed with buffy; dorsal surfaces of hands and feet blackish. Skull with narrow interorbital region; auditory bullae relatively large; upper toothrow relatively short; interpterygoid space relatively wide.

Measurements of type specimen.—Length of head and body 69; length of tail 53; length of hind foot 16; length of ear from crown 7; condyloincisive length of skull 19.5; width across zygomatic arches 10.3; length of nasals 7.8; least interorbital width 3.9; length of upper toothrow 3.7.

Comparisons.—*Mus triton imatongensis* differs from *M. t. triton*, as represented by the type and type series of *Mus naivashae* Heller, from the

Aberdare Mountains, British East Africa, in: Color generally darker, that is with less yellow in the pelage; skull with markedly larger bullae; shorter maxillary toothrow and narrower interorbitum; more vaulted and less laterally expanded cranium.

The only other form with which *Mus triton imatongensis* might be confused is *Mus musculoides*, from which it may be distinguished by the plumbeous instead of pure white belly.

Remarks.—The specimens in the type series were all taken in grassy situations either in coffee plantations or along forest streams. The outstanding characters separating *M. t. imatongensis* from the nominate race are in the development of the auditory bullae and the vaulting of the cranium. These two characters may be of specific importance, but I feel that it is better to refer these animals to *Mus triton* to which they are closely related.

Mus bellus aequatorius, n. subsp.

Type.—Chicago Natural History Museum, no. 79510, adult female, skin and skull, from Torit, Torit District, Equatoria Province, Anglo-Egyptian Sudan. Obtained by J. S. Owen, March 1, 1952.

Specimens examined.—Thirty-one, from: Torit, 29, Ikoto, 1; Obbo, 1.

Distribution.—Known only from the above localities.

Diagnosis.—Coloration of upper parts Clay Color strongly intermixed with black; Clay Color purest on cheeks, above eyes, a thin band on upper arm, and a thin line between the dorsal color and the belly. Dorsum with conspicuous wide blackish stripe, almost lacking Clay Color, from tip of nose to base of tail. Belly, hands, feet, throat, chin, hips, and postauricular and subauricular spots pure white. Rostrum and interorbital region of skull relatively narrow; maxillary toothrow short; sides of anterior palatine foramina not flaring.

Measurements of type specimen.—Total length 82; length of tail 32; length of hind foot 11; length of ear 7; condyloincisive length of skull 15.9; crown length of upper toothrow 2.8; width across zygomatic arches 8.8; least interorbital width 3.1; length of nasals 6.2; width of rostrum at level of infraorbital foramen 2.2.

Comparisons.—From the type of *Mus bellus gondokorae*, *M. b. aequatorius* differs in darker, more clearly defined dorsal stripe; less yellow in pigmented areas; pronounced subauricular and postauricular spots as opposed to a minute subauricular and no postauricular spot in *M. b. gondokorae*; rostrum narrower; toothrow shorter; lateral margins of anterior palatine foramina nearly straight rather than bowed laterad; interorbital region narrower.

Mus bellus aequatorius differs from the type of *M. b. enclavae* in: Color lighter in all respects but with the dark dorsal stripe more pronounced; postauricular and subauricular spots conspicuous (there is only a suggestion of the subauricular spot in *M. b. enclavae*); rostrum narrower; upper toothrow shorter; auditory bullae larger; interorbital region narrower; width of skull at level of temporal root of zygomata narrower; wings of pterygoid less flaring.

Remarks.—Most of the specimens examined came from savanna, but a few were taken in buildings occupied as a laboratory at Torit.

One specimen from Obbo is intermediate in color between *M. b. aequatorius* and *M. b. enclavae* and has only a faint subauricular spot as in the latter. The skull, however, is like that of *aequatorius* in all critical characters. This specimen is, therefore, referred to *aequatorius* but is not considered to lie within the normal range of variation of the typical form.

The most outstanding character of this new subspecies is the pronounced white band below and in back of the ears. This one character alone separates *M. b. aequatorius* from *M. b. enclavae* and *M. b. gondokorae*. In none of the subspecies from British East Africa does this white spot show so conspicuously.

ZOOLOGY.—*Three new species of coccidia from the Canada goose,* Branta canadensis *(Linné, 1758).* MARION M. FARR, U. S. Bureau of Animal Industry. (Communicated by E. W. Price.)

For several years the Zoological Division of the Bureau of Animal Industry and the Disease Section of the U. S. Fish and Wildlife Service have been cooperating in a study to determine the cause or causes of mortality among Canada geese overwintering at Pea Island National Wildlife Refuge, which is located in North Carolina. During this investigation three species of coccidia, apparently not heretofore described, were recovered. The descriptions of these species, as well as notes on the life cycle of one of the species, are given in this paper.

Critcher (1950) reported *Eimeria truncata* (Railliet and Lucet, 1891) from the Canada goose on Pea Island National Wildlife Refuge and suggested that this parasite might be a factor in mortality among Canada geese there. Levine (1951) described *Eimeria magnalabia* from *Branta canadensis interior* on Horseshoe Lake Game Refuge, Illinois. In 1952, he gave a brief description of another new species, *Eimeria brantae*,[1] from the lesser Canada goose, *Branta canadensis leucopareia*.

Eimeria hermani, n.sp. Figs. 1, 2

Sporulated oocyst.—17.5 to 19.5μ by 24.3 to 27.6μ; most frequently 18.9 by 25.6μ. Shape index (width divided by length) 0.64 to 0.76; most frequently 0.71. Shape ovoid, slightly flattened at one end. Micropyle prominent, 3.2μ in diameter, located at narrower flattened pole of oocyst. Oocyst wall colorless, thick, smooth; composed of two layers which are not easily distinguished unless wall is broken as shown in Fig. 2. Outer layer 0.95μ thick, slightly thinner at micropyle; inner layer 0.4μ thick, expanding around micropyle into irregular lobes which hang down into oocyst. A dark line of refraction is visible within wall of sporulated oocyst, particularly at end opposite micropyle; this may represent an inner membrane, although none was seen when wall was broken. No oocystic residual body and no polar body seen. Sporocysts 7.6 to 9.4μ by 13.5 to 14.1μ; each slightly pointed at ends, with thin wall, an inconspicuous Stieda body, and finely granular sporocystic residuum dispersed around sporozoites. Each sporozoite elongated, rounded at one end and pointed at the other, and doubled over within sporocyst. Nucleus of sporozoite almost centrally located, being a little nearer rounded posterior end. A large ellipsoidal refractile body fills rounded end of sporozoite and a smaller spherical, refractile body is just anterior to nucleus. Under favorable conditions (e.g., when slide is gently warmed) sporozoites move about vigorously within sporocyst. Sporulation is completed within 48 hours at room temperature.

Prepatent period.—Five days.

Hosts.—*Branta canadensis* (type host); *Anser anser* (experimental host).

Location.—Throughout small intestine.

Localities.—Pea Island National Wildlife Refuge, North Carolina (type locality); Seney National Wildlife Refuge, Michigan.

This species is named in honor of Dr. Carlton M. Herman, U. S. Fish and Wildlife Service.

Table 1 is a chart of the species of *Eimeria* reported from ducks and geese. Reference to this chart shows that *E. hermani* is readily differentiated from all other species, except, perhaps, *E. brantae* Levine, 1952. However, the oocysts of *E. hermani* are in general larger than those of *E. brantae*.[2] Since the description of *E. brantae* is too inadequate for identification, the present species is considered as new.

Eimeria striata, n.sp. Fig. 3

Sporulated oocyst.—13.7 to 18μ by 18.9 to 23.6μ; majority varying between 15.5 to 17.5μ by 20.2 to 22.9μ. Shape index 0.65 to 0.86, majority 0.72 to 0.78. Shape elliptical to ovoid; micropyle prominent, 2.7μ in diameter. Oocyst wall thick, composed of two layers; outer layer pale yellow, finely striated and pitted, about 0.95μ thick, slightly thinner at micropyle; inner layer smooth, colorless, about 0.4μ thick, expanding slightly at micropyle. One or more refractile polar granules present but no oocystic residuum observed. Sporocysts 7 to 8μ by 10 to 12μ, each with a small Stieda body at one end; the other

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[1] After this paper was submitted, a description and figure of the unsporulated oocyst of *E. brantae* from the feces of *Branta c. parvipes* were published: LEVINE, N. D. *A review of the coccidia from the avian orders Galliformes, Anseriformes and Charadriiformes, with descriptions of three new species.* Amer. Midl. Nat. **49**: 696–719. 1953.

[2] At the micropyle the oocyst wall of *E. hermani* is slightly flattened, and the inner layer of the wall is expanded into irregular lobes, while *E. brantae* is not flattened and the expanded portion of the inner wall is apparently smooth.

end rounded or slightly pointed; coarsely granular sporocystic residuum present. Sporozoites elongated and doubled over within sporocyst, at least 2 refractile bodies within each sporozoite. Sporulation completed within 72 hours at room temperature. However, polar bodies do not usually appear until a day or two after sporulation has been completed.

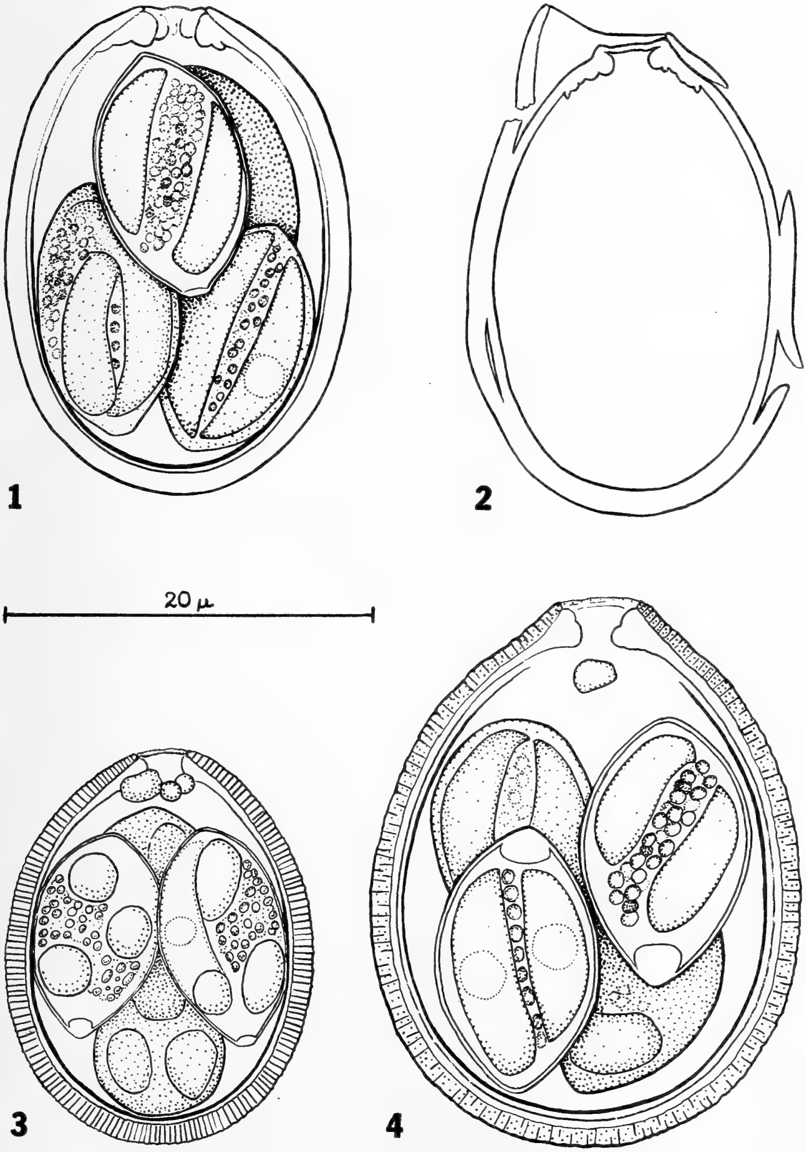
Prepatent period.—A few oocysts on fifth day, major shower on sixth day.

Hosts.—*Branta canadensis* (type host); *Anser anser* (experimental host).

Location.—Small intestine.

Localities.—Pea Island National Wildlife Refuge, North Carolina (type locality); Seney National Wildlife Refuge, Michigan.

Eimeria striata most closely resembles *Eimeria magnalabia* Levine, 1951. However, the oocyst of *E. striata* has one or more polar bodies, each sporocyst has a small Stieda body, the pale yellow outer layer of the oocyst wall becomes thinner around the micropyle and the colorless inner layer becomes thicker around the micropyle. On the other hand the *E. magnalabia* oocyst has neither polar bodies nor Stieda bodies, the brown-



FIGS. 1–4.—1, *Eimeria hermani*, n. sp., sporulated oocyst; 2, *Eimeria hermani*, n. sp., broken oocyst showing the two layers of the wall; 3, *Eimeria striata*, n. sp., sporulated oocyst; 4, *Eimeria fulva*, n. sp., sporulated oocyst.

TABLE 1.—CHARACTERS DIFFERENTIATING OOCYSTS OF SPECIES OF EIMERIA REPORTED FROM DUCKS AND GEESE

Species	Host	Location	Size	Shape	Wall	Micropyle	Residual body	Polar body	Sporulation time	Prepatent period
E. anseris, Kotlan (1932) emend. Kotlan, 1933	Domestic goose	Small intestine, mainly posterior portion	13–18μ × 16–23μ	Pear-shaped	Colorless	Present, prominent	In oocyst and sporocyst		1 to 2 days	7 days
E. brantae, Levine, 1952	*Branta canadensis leucopareia*	Unknown	18 × 24μ	Ovoid	Colorless	Present				
E. bucephalae, Christiansen and Madsen (1948)	*Somateria mollissima*	Entire small intestine	13–20μ × 25–39μ	Ovoid or ellipsoidal; one side may be indented	Light brown; very finely sculptured	Present, rather narrow	In sporocyst only	Few polar inclusions	4 days	
E. fulva, n. sp.	*Branta canadensis*, *Anser anser**	Small intestine	20.2–25.2μ × 25.6–32.4μ	Broadly ovoid, sometimes almost pyriform, slightly flattened at micropyle	Brown outer layer, striated and pitted; colorless smooth inner layer with lobes at micropyle	Present, large	In sporocyst only	Usually present	3 to 4 days	9 days
E. hermani, n. sp.	*Branta canadensis*, *Anser anser**	Small intestine	17.5–19.5μ × 24.3–27.6μ	Ovoid, slightly flattened at micropyle	Colorless, smooth, 2 layers inner layer enlarged at micropyle	Present, large	In sporocyst only	Absent	2 days	5 days
E. magnalabia, Levine, 1951	*Branta canadensis interior*	Feces	15.1–17.3μ × 21.7–24μ	Slightly ovoid	Brownish yellow pitted, enlarged into lobes at micropyle, colorless inner layer?	Present, large	In sporocyst only	Absent		
E. nocens, Kotlan, 1933	Domestic goose	Small intestine, posterior portion	17–24μ × 25–33μ	Egg-shaped, truncated anterior pole	Brown, thick	Present, large				
E. parvula, Kotlan, 1933	Domestic goose	Small intestine, posterior portion mainly	10–14μ × 10–15μ	Round or elliptical	Colorless, delicate	Absent				5 days

E. striata, n. sp.	*Branta canadensis*, *Anser anser**	Small intestine	13.7–18μ × 18.9–23.6μ	Elliptical or ovoid	Pale yellow, outer layer pitted and striated; colorless smooth inner layer thickened at micropyle	Present, large	In sporocyst only	One or more present	3 days	5 to 6 days
E. truncata, (Railliet and Lucet, 1891)	Domestic goose, *Branta c. canadensis*, duck	Kidney, uriniferous tubules	11.7–21.6μ × 14.3–27μ	Ovoid, truncated	Colorless, smooth, delicate	Present large	Occasionally in oocyst, always in sporocyst		1 to 3 days (Kotlan, 1933) (Ridala, 1936)	5 to 6 days (Kotlan, 1933)

* Experimental

ish-yellow outer layer of the oocyst wall is expanded into thick lobes around the micropyle, and the colorless inner layer was visible only at the end opposite the micropyle.

Eimeria fulva, n.sp.

Fig. 4

Sporulated oocyst.—20.2 to 25.2μ by 25.6 to 32.4μ; most frequently 21.6 by 29.7μ. Shape index 0.64 to 0.85, majority varying between 0.71 and 0.77. Shape usually broadly ovoid, occasionally almost pyriform, slightly flattened at narrower pole. Micropyle prominent, 3.3 to 4μ in diameter, located at narrower pole. Oocyst wall 2-layered; outer layer pitted and transversely striated, brownish yellow in color, 1μ thick and slightly thinner at micropyle; inner layer smooth and colorless, 0.6μ thick and expanding into a rather smooth ridge around micropyle. A dark line of refraction is present within inner surface of oocyst wall, especially evident at end opposite micropyle; this may represent an inner membrane. A large refractile polar granule is usually present at narrower pole of sporulated oocyst. Sporocysts 8.3 to 9.7μ by 13.5 to 14.8μ, pointed at both ends, each sporocyst with a prominent Stieda body. A coarsely granular sporocystic residuum partially obscures elongated sporozoites which are doubled over within sporocyst. Sporulation completed within 72 to 96 hours at room temperature.

Developmental stages.—Experimental infections in both domestic and Canada geese showed grossly that the parasite occurred throughout the small intestine. A thickening and congestion of the intestinal wall and an accumulation of greenish mucus accompanied severe infection. The time required for the completion of the life cycle was nine days.

Studies of tissue fixed on the last four days of the life cycle showed that the developmental stages were most abundant in the anterior portion of the small intestine. About 144 hours after inoculation, numbers of small schizonts, each measuring about 13 by 15μ and containing 16 to 30 small merozoites, were observed within the epithelial cells of the tips and sides of the villi. About 169 hours after inoculation, numbers of small schizonts were still present in the epithelium and numbers of immature gametocytes, which occurred singly, or in groups of 2, 3, 4, and 5, were found within the epithelium of the tips and sides of the villi; some were also seen in the tunica propria and in the necks and fundi of the intestinal glands. In cases where the host cell was not completely destroyed the cytoplasm was stretched in a thin line around the parasite and there was no hypertrophy of the nucleus. However, in many cases the host cell was destroyed, consequently, some of the gametocytes had moved to the basement membrane and others had penetrated into the tunica propria. Often there was a clear space between the parasite and the host tissue. At 193 hours after inoculation, masses of developing gametocytes and numbers of nearly mature macrogametocytes and microgametocytes were present. Microgametocytes measured between 29 to 37.7μ by 34.8 to 46.4μ and the more mature ones appeared to be multicentric. The more mature macrogametocytes varied from 20.3 to 23.7μ by 26 to 30.4μ. At 217 hours after inoculation, masses of gametocytes were seen along the basement membrane and numbers of oocysts were present.

Prepatent period.—Nine days.

Hosts.—Branta canadensis (type host), *Anser anser* (experimental host).

Location.—Throughout small intestine.

Localities.—Pea Island National Wildlife Refuge, North Carolina (type locality); Seneca Falls, N. Y.; Seney National Wildlife Refuge, Michigan.

Type specimens.—U. S. N. M. Helm. Coll. no. 47605.

This species is unlike any of the coccidia described from geese and ducks except *E. nocens* Kotlan, 1933. *E. fulva* differs from *E. nocens* in that the outer wall of the oocyst of *E. fulva* is pitted and transversely striated; and a large polar body is usually present in the sporulated oocyst and the parasite occurs throughout the small intestine. Kotlan (1933) did not mention the shape of the sporocysts of *E. nocens* nor did he state whether a Stieda body was present.

LITERATURE CITED

Critcher, S. *Renal coccidiosis in Pea Island Canada geese.* Wildlife in North Carolina **14:** 14–15, 22. 1950.

Christiansen, M., and Madsen, H. Eimeria bucephalae *n.sp.* (*Coccidia*) *pathogenic in goldeneye* (Bucephala clangula *L.*) *in Denmark.* Danish Rev. Game Biol. **1:** 61–73. 1948.

Kotlán, S. *Adatok a vízimadarak* (*kacsa, liba*) *coccidiosisának ismeretéhez.* Állat. Lapok. **55:** 103–107. 1932.

———. *Zur Kenntnis der Kokzidiose des Wassergeflugels. Die Kokzidiose der Hausgans.* Zentralbl. Bakteriol., Abt. 1, Orig., **129:** 11–21, 1933.

Levine, N. D. Tyzzeria *and* Eimeria *from the Canada goose.* Proc. Amer. Soc. Protozool. **2:** 17. 1951.

———. Eimeria magnalabia *n.sp. and* Tyzzeria *sp.* (*Protozoa: Eimeriidae*) *from the Canada goose.* Cornell Vet. **42:** 247–252. 1952.

Railliet, A., and Lucet, A. *Note sur quelques espèces de coccidies encore peu étudiées.* Bull. Soc. Zool. France **16:** 246–250. 1891.

Ridala, V. *Hanede neerukokstidioos.* (*Renal coccidiosis of geese.*) Eesti Loomaarstlik Ringvaade **12:** 177–199. 1936.

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VOL. 43 November 1953 No. 11

GEOLOGY.—*The Geological Society of Washington.*[1] ROLAND W. BROWN, U. S. Geological Survey.

Until the organization of the Geological Society of Washington on February 25, 1893, the geologists of Washington and vicinity had no adequate outlet for full discussion of their mutual geological interests and studies. The Philosophical Society, founded in 1871, provided opportunity for only an occasional paper on a geological subject. Consequently, realization of this need early in 1893 precipitated a call, signed by 25 persons, for a meeting to consider the advisability of creating a geological society. This meeting, attended by 23 persons, was held on Tuesday, February 21, in the office of C. D. Walcott, Director of the United States Geological Survey, then located in the Hooe Building on the south side of F Street midway between 13th and 14th Streets, NW., about where the Capitol Theater now stands. The group decided unanimously to organize a society and, after appointing a committee, consisting of C. D. Walcott, chairman, J. S. Diller, secretary, S. F. Emmons, W. H. Holmes, and G. P. Merrill, to prepare a constitution and bylaws, selected Saturday, February 25, for the organization meeting. This meeting was also held in the office of Director Walcott, with 50 persons present. A constitution and bylaws were adopted and the following officers were elected: President, C. D. Walcott; Vice-Presidents, S. F. Emmons, W. H. Holmes; Secretaries, Whitman Cross, J. S. Diller; Treasurer, Arnold Hague; Members-at-large of the Council, G. F. Becker, T. M. Chatard, G. H. Eldridge, G. K. Gilbert, G. P. Merrill. The purpose of the Society was stated to be "the increase and diffusion of geological knowledge."

The first regular meeting was held on Wednesday, March 8, with 49 persons present, in the basement of the Cosmos Club at Madison Place and H Street, NW. Maj. J. W. Powell opened the program with a review of the advance of geology in the United States as influenced by the work of the geological surveys in the West under government auspices. Then H. W. Turner spoke on "The Structure of the Gold Belt of the Sierra Nevada" and S. F. Emmons on "The Geological Distribution of the Useful Metals." By this date 109 persons had signed the constitution and, according to a resolution adopted by the Society, were entitled to enrollment as founders—upon payment of dues, $2 for active and $1 for corresponding membership.

With relatively few exceptions all subsequent meetings until May 1952 were held at the Cosmos Club at Madison Place and H Street, first in the basement, then in the renovated carriage shed that was euphemistically called the Assembly Hall. Since October 1952 the meetings have been held at the new location of the Cosmos Club at Massachusetts and Florida Avenues, NW.

At the annual meeting on December 13, 1893, with 20 persons present, the secretary reported a total of 134 members, 112 active and 22 corresponding. The treasurer reported receipts of $177 and disbursements of $79.17, leaving a balance of $97.83; but 30 members, about 23 per cent of the membership, had not paid their dues! For this there were, doubtless, extenuating circumstances. It will be recalled that on March 4, 1893, Grover Cleveland became President

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[1] Publication authorized by the Director, U. S. Geological Survey. This paper contains the substance of an informal communication, celebrating the sixtieth anniversary of the Society at the 723d meeting, February 25, 1953.

(for the second time), and Adlai E. Stevenson, Vice-President of the United States. Not because of these men but in spite of them, the clamor, particularly by westerners, for the free and unlimited coinage of silver, the unchecked speculation in dubious enterprises, and the unfavorable foreign trade balance caused normal business to be very cautious. Production fell off. One bank after another failed until more than 400 had collapsed, spreading much distress across the land. This was the Panic of 1893, and its tight money very likely had much to do with the nonpayment of dues by some of the founding fathers of the Society. Nevertheless, after things leveled off, and after a courteous lapse of time, the list of founders on February 28, 1895, as published in the proceedings of the Society, totaled 98. Of all these, according to present information, the only living founder is T. W. Stanton, now 92 years old.

Sixty years have passed since the Society was founded. The twenty-fifth anniversary was unobserved because that came during war conditions in 1918 when many members were not in Washington and only one meeting a month was held. The fiftieth anniversary was celebrated appropriately on February 24, 1943. President Herbert Insley called on the attending founders and some of the older members for reminiscences. T. W. Stanton told about the telephone call inviting the paleontologists working at the National Museum to the first meeting to consider organization of a society; and also recalled, as he humorously put it, how he and F. H. Knowlton in the early 1900's had solved the Laramie problem! George Steiger showed pictures of the old U. S. Geological Survey chemical laboratory in the F Street building and said that when Survey funds had been cut 50 per cent and personnel was being reduced during the depression of 1893, F. W. Clarke was retained because he was the best chemist and he, Steiger, was kept because he received the least money. W. C. Mendenhall remembered his awe in the presence of Gilbert, Powell, and Dutton. T. W. Vaughan related stories about Gilbert and others. G. W. Stose had lantern slides showing pictures of Walcott, Powell, and others. Finally, Arthur Spencer said dryly that he also could tell stories about the "old boys" but that he considered such to be inappropriate at that time! At the close of the meeting, beer, cider, doughnuts, and pretzels were served.

Condensed proceedings of the Society for the first years were published by the Society. At the turn of the century the programs began to be reported fairly regularly in *Science*; and from 1911 to 1949, with a few interruptions, they were published in the *Journal of the Washington Academy of Sciences*. Some of these proceedings are to be found in bound volumes on the shelves of the Library of the U. S. Geological Survey. Deposited there also are some of the books containing the secretarial minutes.

How shall the worth of the Society and its activities during the past 60 years be appraised? First, the Society has provided the opportunity for a stimulating fellowship of younger with older geologists. Second, the Society has cooperated with other groups, such as being host to the Geological Society of America when that organization has held its annual meeting in Washington. In 1898 the Society became affiliated with the Washington Academy of Sciences, with which it has sometimes held joint meetings. Third, through the faithful performance of duties its officers have provided a long succession of instructive, and nearly always lively, programs. These cannot be analyzed here seriatim, but the list of presidential addresses at the annual meetings in December gives a cross section of the kind and scope of subject matter that has been discussed. In this list, an asterisk (*) after a name indicates a founder. If the address was given at some other time than the annual meeting, that date is given. If known, the place of publication is cited.

PRESIDENTS OF THE SOCIETY AND THEIR ADDRESSES

1893, 4. C. D. WALCOTT.* The United States Geological Survey. (Pop. Sci. Monthly **46**: 479–498. 1895.)

1895. G. K. GILBERT.* The origin of hypotheses. (Science **3**: 1–13. 1896.)

1896. S. F. EMMONS.* The geology of government explorations. (Science **5**: 1–15, 42–51. 1897.)

1897, 8. ARNOLD HAGUE.* Early Tertiary volcanoes of the Absaroka Range. (Science **9:** 425–442. 1899.)

1899, 0. Whitman Cross.* The development of systematic petrography in the nineteenth century. (Journ. Geol. **10:** 332–376, 451–499. 1902.)

1901, 2. J. S. Diller.* The wreck of Mt. Mazama. (Science **15:** 203–211. 1902.)

1903, 4. C. W. Hayes.* Should there be a Federal department of mines?

1905, 6. G. P. Merrill.* Development of the glacial hypothesis in America. (Pop. Sci. Monthly **68:** 300–322. 1906.) The composition and structure of meteorites compared with those of terrestrial rocks. (Amer. Journ. Sci. **27:** 469–474. 1909.)

1907, 8. Waldemar Lindgren.* Present tendencies in the study of ore deposits. (Econ. Geol. **2:** 743–762. 1907.)

1909. George O. Smith. Scientific by-products of applied geology. April 13, 1921. (Journ. Eng. and Min. **111:** 66–67. 1921; Journ. Washington Acad. Sci. **11:** 203–207. 1921.)

1910. M. R. Campbell.* Review of theories regarding origin and accumulation of oil. (Econ. Geol. **6:** 363–395, 812. 1911.)

1911. Alfred H. Brooks. Applied geology. (Journ. Washington Acad. Sci. **2:** 19–48. 1912.)

1912. T. W. Stanton.* Some variations in Upper Cretaceous stratigraphy. (Journ. Washington Acad. Sci. **3:** 55–70. 1913.)

1913. F. L. Ransome. Tertiary orogeny of the North American Cordillera and its problems. (Problems of American geology: 287–376. 1915.)

1914. Arthur Keith.* Main features of Appalachian structure. (Bull. Geol. Soc. Amer. **34:** 309–380. 1923.)

1915. T. W. Vaughan. Some problems in the geologic history of the perimeters of the Gulf of Mexico and the Caribbean Sea.

1916. Arthur Spencer. Stream terraces in the Rocky Mountain province.

1917. W. C. Mendenhall.

1918. F. H. Knowlton.* Evolution of geologic climates. (Bull. Geol. Soc. America **30:** 499–566, 1919.)

1919. E. O. Ulrich. Major causes of land and sea oscillations. (Journ. Washington Acad. Sci. **10:** 57–78. 1920.)

1920. David White.* Deposition of oil shales. April 13, 1921.

1921. G. W. Stose. Relation of faults to folds in the Appalachians.

1922. W. C. Alden. Physiographic development of the northern Great Plains. (Bull. Geol. Soc. Amer. **35:** 385–423. 1924.)

1923. G. F. Loughlin. The development and outlook of economic gelogy.

1924. F. E. Wright. Methods for relative gravity measurements.

1925. L. W. Stephenson. Major features in the geology of the Atlantic and Gulf Coastal Plain. (Journ. Washington Acad. Sci. **16:** 460–480. 1926.)

1926. N. H. Darton.* Erosion planes and overlaps in the eastern Maryland region. December 12, 1934.

1927. Charles Butts. Variations in Appalachiah stratigraphy. (Journ. Washington Acad. Sci. **18:** 357–380. 1928.)

1928. D. F. Hewett. A review of European metal production.

1929. S. R. Capps. Glaciation in Alaska. (U. S. Geol. Surv. Prof. Paper **170:** 1–8. 1931.)

1930. G. R. Mansfield. Problems of the Phosphoria formation in the Rocky Mountains. (Econ. Geol. **26:** 353–374. 1931.)

1931. O. E. Meinzer. History and development of ground water hydrology. (Journ. Washington Acad. Sci. **24:** 6–32. 1934.)

1932. F. E. Matthes. The evolution of the glacial cirque.

1933. C. N. Fenner. Some magmatic problems. (Journ. Washington Acad. Sci. **24:** 113–124. 1934.)

1934. H. G. Ferguson.

1935. W. T. Schaller. A mineralogist ventures in geology.

1936. M. I. Goldman. Petrographic features of salt dome cap rock.

1937. R. C. Wells. Present trends in geochemistry. (Journ. Washington Acad. Sci. **28:** 415. 1938.)

1938. H. D. Miser. Our petroleum supply. (Journ. Washington Acad. Sci. **29:** 93–109. 1939.)

1940. J. T. Pardee. Unusual currents in glacial Lake Missoula. (Bull. Geol. Soc. Amer. **53:** 1569–1599. 1942.)

1941. J. B. Reeside, Jr. Upper Cretaceous sediments of the western States. (U. S. Geol. Surv. Oil and Gas Inv. Prelim. Map 10. 1944.)

1942. C. S. Ross. Clays and soils in relation to geologic processes.

1943. Herbert Insley. Contact deposits in an artificial silicate magma. (Journ. Washington Acad. Sci. **35:** 156–161. 1945.)

1944. George Tunell. Some thermodynamic and leptologic threads in the geologic tapestry.

1945. L. W. Currier. Granitization as a regional metamorphic process in New England. (Journ. Washington Acad. Sci. **37:** 75–86. 1947.)

1946. W. H. Bradley. Limnology and the Eocene lakes of the Rocky Mountain region. (Bull. Geol. Soc. Amer. **59:** 635–648. 1948.)

1947. W. P. Woodring. Central America land bridge and sea land.

1948. W. W. Rubey. The problem of changes in composition of sea water and atmosphere during the geologic past. (Bull. Geol. Soc. Amer. **62:** 1111–1148. 1951.)
1949. J. S. Williams. Boundaries between geologic systems, illustrated by Paleozoic examples.
1950. L. H. Adams. Orbis terrarum: a century of progress.
1951. A. N. Sayre. Our water supply.
1952. Josiah Bridge. The extent and significance of the post-Lower Ordovician discontinuity.
1953. Arthur A. Baker.

PALEONTOLOGY.—*A new pelecypod genus from Upper Triassic strata in Peru.*[1]

David Nicol and William T. Allen, U. S. National Museum.

Dr. R. W. Imlay, of the U. S. Geological Survey, showed the senior author a collection of fossils from the Atacocha Mine near Cerro de Pasco, Peru. Among the material were six valves of a peculiar species of pelecypod which Dr. Imlay thought might belong to the genus *Tutcheria* Cox, 1946. After four of the specimens were prepared, it became obvious that this material represented an undescribed genus which seems to be most closely related to the family Cardiniidae.

Family Cardiniidae Zittel, 1881

Isopristes Nicol and Allen, n. gen.

Type species.—Isopristes crassus Nicol and Allen, n. sp.

Description.—Shell thick, porcellaneous(?); valve outline subquadrate, elongate, of slight convexity; no escutcheon or lunule, although area below beak has small but deep depression; no apparent gape; beaks prosogyrate, located nearly at anterior end of dorsal border; ornamentation consisting of gentle concentric folds which are steeper at the ventral side and appear to be resting stages of growth; radial ornamentation consisting of many small, closely spaced ribs; interior margin has small but well-marked crenulations; anterior adductor muscle scar small, nearly round, deep and located below the anterior end of the hinge; posterior adductor muscle scar twice as large but not so deeply indented, located below the posterior end of the hinge plate; pallial line distinct, integripalliate (musculature much like that of the trigoniids).

The hinge, unfortunately, is imperfectly preserved in all specimens. The most striking feature is the well-marked ridges on the sides of the teeth, which are like those of *Trigonia* except that the ridges are much farther apart, larger, and more rounded. The preserved part of the hinge is like that of the unionids or cardiniids. On the left valve there is an elongate tooth which is nearly parallel to the dorsal border. The anterior end of this tooth is just behind the beak. At its forward extremity it is joined with another tooth which is shorter and nearly perpendicular to the dorsal border. Anterior to this latter tooth is a wide flat area, and at the anterior end of the hinge plate are two small teeth which nearly surround a socket. The right valve has one prominent tooth which fits in the socket between the two prominent elongate teeth of the left valve. There also appears to be one small round tooth on the anterior portion of the hinge plate. The hinge plate of *Isopristes* is much more massive than that of the trigoniids and is more like some of the unionids and cardiniids. There is a groove behind the umbo and below the dorsal margin which may have lodged the ligament. Whether the ligament was external or internal cannot be ascertained.

Comparisons.—Isopristes resembles some of the genera included in the family Cardiniidae. Unfortunately, the family is not well defined, and its relationship to other groups is not well understood. *Isopristes* most closely resembles *Cardinia* Agassiz, 1841, in outline position of beaks, and some aspects of the hinge, but differs from it in having radial ribs and a crenulated interior margin. *Pachycardia* Hauer, 1857, has an outline and hinge that somewhat resemble *Isopristes* but differs from it in the absence of radial ribs, absence of crenulations on the interior margin, and the presence of a lunule. In outline and position of the beaks *Isopristes* is also similar to *Pinzonella* Reed, 1932, from the Triassic of Brazil; however, *Pinzonella* differs from *Isopristes* in having a posterior ridge on the exterior of the shell and in not having radial ornamentation

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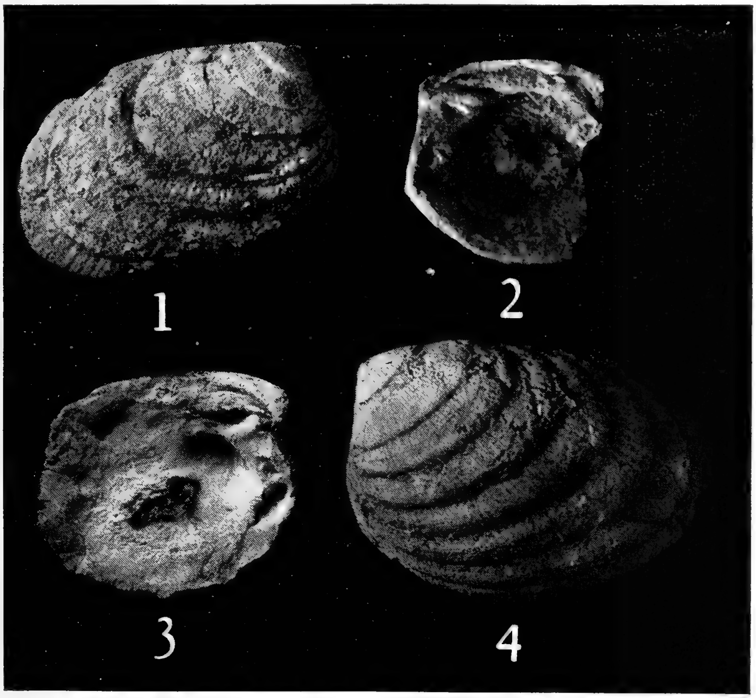
[1] The authors greatly appreciate the help of Dr. R. W. Imlay, of the U. S. Geological Survey, for allowing us to work on the material and giving us helpful suggestions on locality and literature data. R. F. Johnson, of the U. S. Geological Survey, gave us additional locality information.

and crenulations on the interior margin. The hinge and outline of *Pinzonellopis* Mendes, 1944, also from the Triassic of Brazil, are somewhat like those of *Isopristes*, but *Pinzonellopis* differs from it in having the beak near the center of the dorsal border and in not having radial ribs and a crenulated interior margin. *Isopristes* also resembles some species of *Paleocardita* Conrad, 1867, although it has no lunule, and its hinge is different.

Isopristes crassus Nicol and Allen, n. sp.

Figs. 1–4

Description.—Shell thick, porcellaneous(?); valve outline subquadrate, dorsal and anterior borders nearly straight, ventral margin gently rounded, posterior border broadly arched; ornamentation consisting of six to eight concentric folds which appear to be resting stages of growth and are steeper on ventral side; radial ornamentation consisting of numerous small, rounded, closely-spaced radial ribs; anterior, ventral, and posterior interior margins have numerous small closely spaced crenulations; lunule and escutcheon apparently absent, but a small and deep depression present under beaks; beaks prosogyrate, located at anterior end of dorsal margin; anterior adductor muscle scar small, round, deep, situated below anterior end of hinge plate; posterior adductor scar larger, not so deep, located below posterior end of hinge plate; pallial line integripalliate, well marked, located far from margin of shell; hinge plate high and well developed; left valve has one elongate tooth which is nearly parallel to dorsal margin and terminates under beak; tooth has coarse schizodont projections on ventral side; this tooth is connected with a shorter one at anterior end; the second tooth has few schizodont projections on dorsal side, and is nearly perpendicular to hinge plate; wide flat area present between the shorter tooth and a socket which appears to be almost surrounded by two small teeth located near anterior end of hinge plate; details of this part of hinge not well preserved. Right valve appears to have two teeth; one somewhat elongate, fits between



FIGS. 1–4.—*Isopristes crassus*: 1, Exterior view of right valve, paratype, U. S. N. M. no. 108692a; 2, interior view of part of right valve, paratype, U. S. N. M. no. 108692b; 3, interior view of part of left valve, holotype, U. S. N. M. no. 108691; 4, exterior view of left valve, paratype, U. S. N. M. no. 108692. All figures × 1. All specimens are from Upper Triassic (Noric Stage); Atacocha Mine, 34 km northeast of Cerro de Pasco, Peru.

the two large teeth of left valve; the other tooth is small and round, fits into socket at anterior end of hinge plate of left valve; hinge of right valve not so well preserved as that of left valve.

Measurements in mm.—Some specimens are too incomplete to be measured accurately.

	Height	Length	Convexity (one valve)
Holotype 108691			12.2
Paratype 108692	35.3	49.3	16.7
Paratype 108692a	29.3	44.6	11.7
Paratype 108692b	27.3		10.7

Comparisons.—*Isopristes crassus* most closely resembles *Unio crassissimus* Sowerby, 1817, and *Unio listeri* Sowerby, 1817, but it differs from both these species in having a crenulated interior margin and radial ribs.

Types.—Holotype, left valve, U. S. N. M. no. 108691; five paratypes, four right valves and one left valve, U. S. N. M. no. 108692.

Age.—According to Dr. R. W. Imlay (oral communication) the bed in which *Isopristes crassus* was found is Upper Triassic (Noric Stage).

Locality.—U. S. Geological Survey locality no. 24388; Atacocha Mine, 16 km by airline (34 km by road) northeast of Cerro de Pasco, Department of Pasco, Atacocha District, Peru. The fossils came from the north side of Quebrada Chicrin, 215 meters N.85°E. from the portal of the 4,000-meter level of the Atacocha Mine.

REFERENCES

Agassiz, L. *Études critiques sur les mollusques fossiles. Monographie des Myes.* 287 pp., 39 pls. Neuchatel, 1842–1845.

Bittner, A. *Lamellibranchiaten der Alpinen Trias.* Abh. Geol. Reichsanstalt. **18**(1): 235 pp., 24 pls. 1895.

Cox, L. R. Tutcheria *and* Pseudopis, *new lamellibranch genera from the Lias.* Proc. Malac. Soc. London **27**(1): 34–48, pls. 3–4. 1946.

———. *Proposed use of the plenary powers to validate the generic name "*Cardinia*" (class Lamellibranchiata) as from Agassiz [1841], for use in its accustomed sense.* Bull. Zool. Nomenclature **4**: 59–64. 1951.

———. *Notes on the Trigoniidae, with outlines of a classification of the family.* Proc. Malac. Soc. London **29**(2–3): 45–70, pls. 3–4. 1952.

Mendes, Josué C. *Lamelibrânquios Triássicos de Rio Claro (Estado de São Paulo).* Univ. S. Paulo Faculdade Filosofia, Ciências e Letras, Bol. 45, Geol. no. 1: 41–74, 2 pls. 1944.

Reed, F. R. Cowper. *Triassic fossils from Brazil.* Ann. Mag. Nat. Hist., ser. 10, **2**(7): 39–48, 1 pl. 1928.

———. *Some new Triassic fossils from Brazil.* Ann. Mag. Nat. Hist., ser. 10, **10**(59): 479–487, pl. 19. 1932.

Sowerby, James. *The mineral conchology of Great Britain* **2**: 251 pp., 203 pls. London, 1817–1818.

Waagen, Lukas. *Die Lamellibranchiaten der Pachycardientuffe der Seiser Alm, etc.* Abh. Geol. Reichsanstalt **18**(2): 180 pp., pls. 25–34. 1907.

Zittel, Karl A. *Handbuch der Palaeontologie* **1**(2): 893 pp., 1,109 text figs. München und Leipzig, 1881–1885.

ENTOMOLOGY.—Hollandipsylla neali, *a new genus and new species of flea from North Borneo, with comments on eyeless fleas (Siphonaptera).* Robert Traub, Lt. Col., M.S.C., Department of Entomology, Army Medical Service Graduate School, Washington, D. C.[1]

A new genus of ceratophyllid flea was among the distinctive ectoparasites collected in North Borneo during investigations on arthropod vectors and rodent reservoirs of disease conducted by a joint U. S. Army–British Colonial Office Medical Research Unit in July and August 1951. This new genus, collected from a flying squirrel, is described and illustrated below.

Hollandipsylla, n. gen.

Unique among squirrel fleas of the subfamily Ceratophyllinae in being eyeless and in possessing only three pairs of lateral plantar bristles on the last segment of the tarsi, two proximal pairs being displaced mesad.

Caput integrecipit. Eye completely vestigial. Pre-antennal region with two rows of bristles. Frontal tubercle small. Postantennal region with but one complete row of bristles and that marginal. Antennal segment II with bristles short in male, not reaching beyond proximal fourth of club; in female, extending beyond middle of club. Antennal groove extending onto propleuron in male. Labial palpi subequal in length to forecoxae. First vinculum or link plate (Fig. 1, *VC. 1*) received in distinct sinus of prosternosome; second and third vincula well developed; fourth

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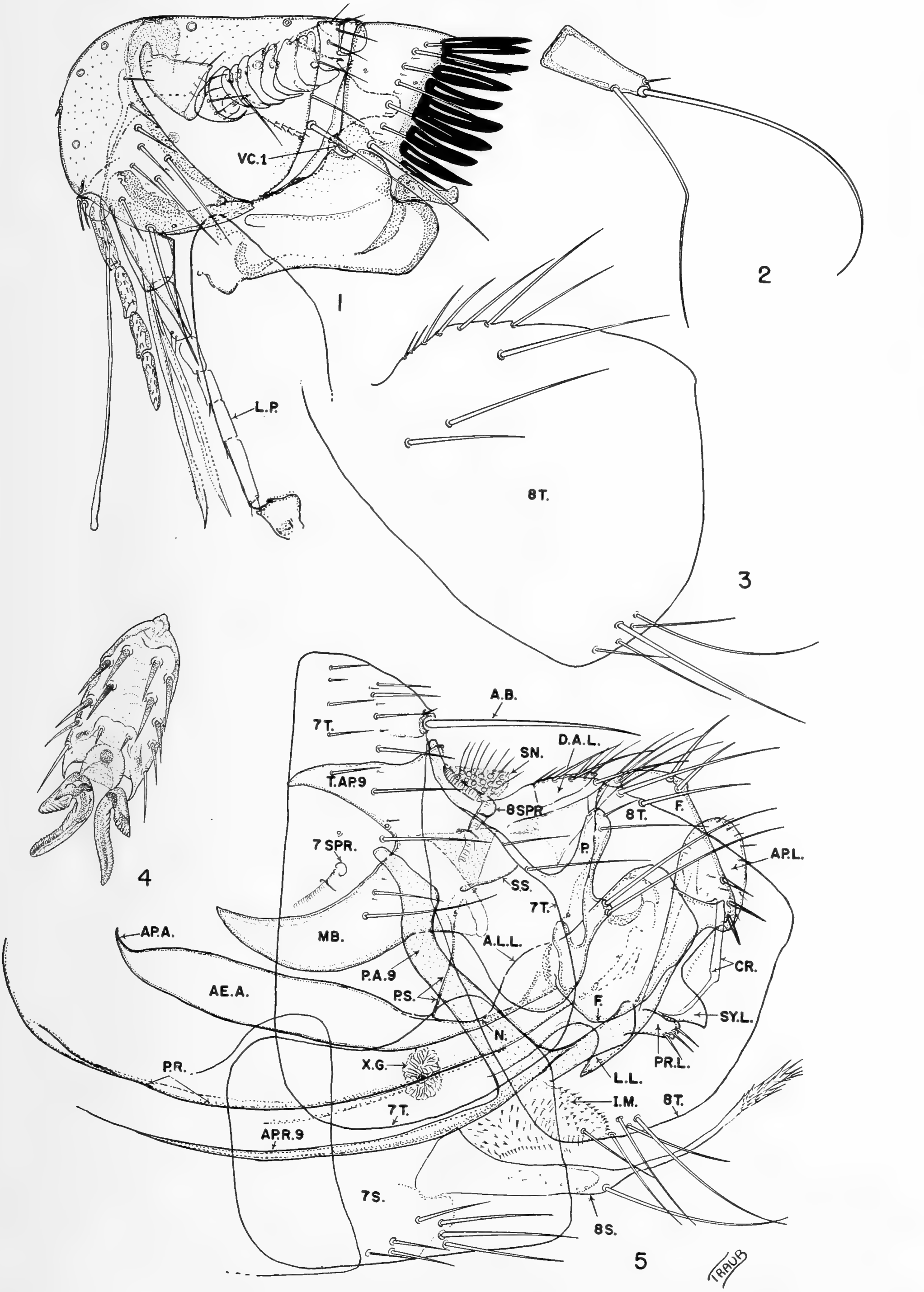
[1] The illustrations were prepared by the author, with the exception of Fig. 4, which was drawn by Thomas Evans, of the Department of Entomology, Army Medical Service Graduate School, to whom I am indebted.

absent. Pronotal comb consisting of about 11–13 spines on a side; spines typically about as long as pronotum. Pronotum with one row of long bristles. Dorsolateral bristles of tibiae mainly paired, and of unequal length; "tibial comb" therefore lacking. Procoxae with many lateral bristles



FIGS. 1–5.—*Hollandipsylla neali*, n. gen., n.sp.: 1, Head, male; 2, anal stylet, female; 3, eighth tergum, male; 4, fifth segment of male hind tarsus; 5, modified abdominal segments, male.

scattered over length of segment; other coxae with very few such bristles and these marginal or submarginal; mesal bristles virtually absent. Profemora lacking lateral, nonmarginal bristles. Lateral metanotal area (Fig. 9, *L.M.*) distinct. Lacking a pleural arch, i.e., pleural ridge of metasternosome not fitting into a socket. The skeletal sclerotization formed by dorsal ridge of lateral metanotal area and the pleural ridge extending dorsad into metanotum but becoming weakly sclerotized before reaching dorsal region of metanotum. Metanotum and some of typical abdominal terga with apical spinelets. Metepisternum lacking a squamulum. Meso- and metanotum and unmodified abdominal terga with two rows of bristles. First segment of hind tarsus subequal in length to II and III. Fifth segment of all tarsi bearing only three pairs of lateral bristles; with two proximal pairs displaced towards midline (Fig. 4). Mesotarsal segment V relatively broad, only about twice as long as broad. Typical abdominal spiracles small; on anterior segments resembling a flattened ovoid. Small apical teeth present on anterior abdominal terga. Male with one antesensiliary (antepygidial) bristle, female with three or four. Eighth sternum reduced to a long narrow structure which is produced apically into an elongate filamentous process. Distal arm of male ninth sternum with a subacute secondary proximal lobe (Fig. 11, *SY.L.*). Lateral lobes of aedeagus (Fig. 10, *L.L.*) well developed and extending proximad of proximal lobes of distal arm of ninth sternum. Crochets (*CR.*) fairly large but weakly sclerotized; apically subtruncate. Movable finger of digitoid bearing spiniforms. Penis rods uncoiled (Fig. 5, *P.R.*). Anal stylet (Fig. 2) with an apical and also a ventromarginal long bristle. Ventral anal lobe rounded, not angulate. Bursa copulatrix (Fig. 6, *B.C.*) apically subglobose and with a long vermiform subacute duct. Spermatheca (Fig. 7, *SP.*) with head much longer than broad, and longer than tail.

Genotype.—Hollandipsylla neali, n. sp. The genus is named for George P. Holland, head, Systematic Entomology, Department of Agriculture, Ottawa, Canada, whose studies on Siphonaptera have been truly outstanding and to whom his coworkers in the field are greatly indebted.

Hollandipsylla neali, n. sp.

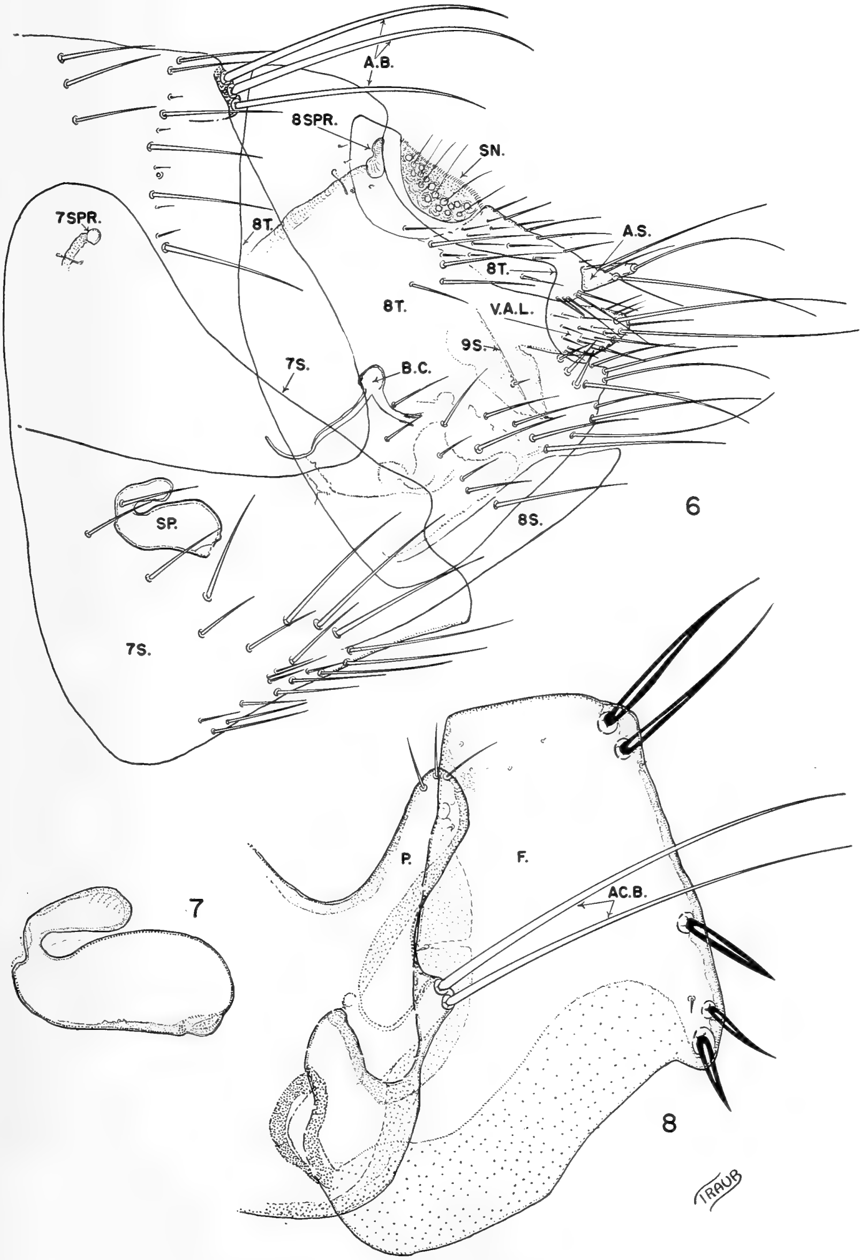
Types.—Holotype male and allotype female, ex *Hylopetes* sp., a small flying squirrel, North Borneo, Mt. Kinabalu, Tenompok, elevation 5000 ft.; collected by R. Traub, 1951; host collected by D. H. Johnson. No other specimens known. Types deposited in U. S. National Museum.

Head (Fig. 1).—Pre-antennal region with a posterior row of three bristles preceded by a row of about five or six much smaller bristles, of which the upper two or three in the male border the antennal groove. Eye completely vestigial, inapparent. The genal process subacute. Labial palpi five-segmented, reaching nearly to apex of forecoxae. Maxillary palpi with second segment subequal to first in length; palpi extending to about level of apex of third segment of labial palpi. Scape of antenna with marginal short bristles. Second antennal segment with apical bristles short in male, not reaching beyond apex of third segment; in female some of these bristles reaching to level three-quarters length of club. Postantennal region with a long bristle above midpoint of dorsal margin of antennal groove and with a caudomarginal row of bristles; ventralmost of row by far the longest; with a series of very short bristles in one or two longitudinal rows delimiting border of antennal groove.

Thorax.—Pronotum with a row of about seven bristles per side; with a comb of about 10 or 11 spines on a side in the male, 12 or 13 in the female; the spines fairly straight or slightly concave. Most spines slightly longer than pronotum is broad, as measured from anterior margin to base of spine. Mesonotum (Fig. 9, *MSN.*) with two rows of bristles. Mesonotal flange on each side with two or three pseudosetae (*PS.S.*). Mesepisternum (*MPS.*) with four or five fairly long bristles. Mesepimere (*MPM.*) with about seven such bristles, of which three long ones are in a horizontal line slightly below level of third vinculum. Metanotum (*MTN.*), together with its flange, as long as mesonotum; flange with one dorso-apical tooth. Lateral metanotal area (*L.M.*) slightly less than twice as long as broad; with three or four bristles, of which those near posterior margin are longest. Metepisternum (*MTS.*) with one long bristle in posterodorsal region flanked by one or two shorter ones. Metepimere (*MTM.*) with about six or seven bristles in three rows. Spiracle here is a short, oblate spheroid.

Legs.—Profemur with one fairly long apical ventromarginal bristle and two such proximal bristles; lacking lateral nonmarginal bristles; with only one mesal nonmarginal bristle; mesofemur the same; metafemur quite similar but with an additional small ventromarginal subproximal bristle and lacking the mesal one. Protibia with stout dorsomarginal bristles arranged as follows: 1-2-2-2-1-2-2; mesotibia: 1-2-2(1 in female)-2-1-2-2; metatibia: 1-2-1-2-2-1-2-2. In mesotarsus, third segment with a distal bristle which extends beyond apex of fourth; in metatarsus this bristle merely reaching apex of fourth. Measurements (in microns) of tibiae and segments of tarsi (petiolate base deleted) of holotype as follows:

Leg	Tibia	Tarsal Segments				
		I	II	III	IV	V
Pro-	188	70	64	62	47	105
Meso-	317	141	118	82	59	112
Meta-	398	376	236	141	87	130



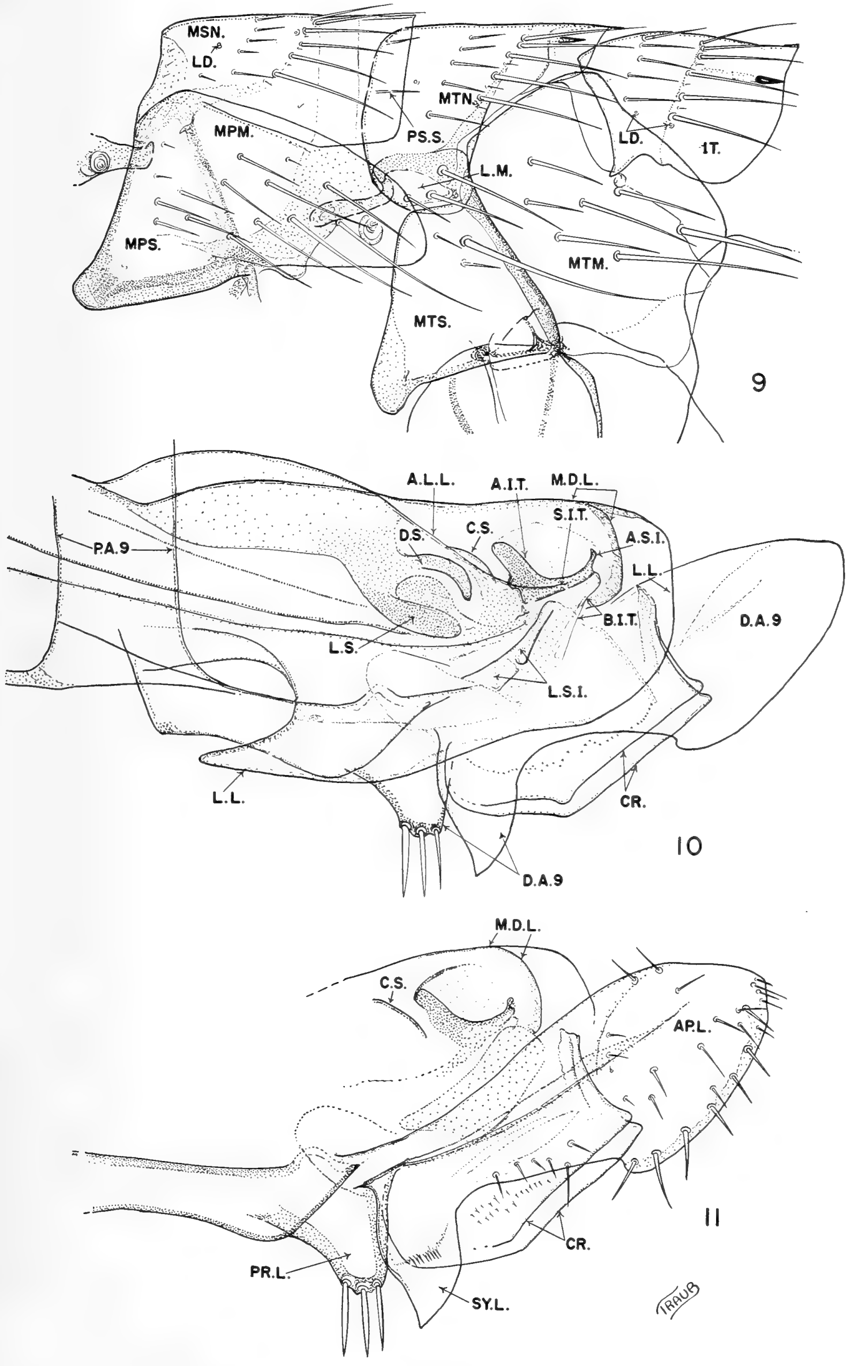
FIGS. 6–8.—*Hollandipsylla neali*, n. gen., n. sp.: 6, Modified abdominal segments, female; 7, spermatheca; 8, process and digiloid of male clasper.

Abdomen.—First tergum (*1T.*) with two rows of bristles and one apical spinelet per side. Basal sternum lacking lateral or mesal bristles; with one ventromarginal bristle in male, two in female. Terga II to IV with apical spinelets as follows: 2-2-1 per side. First row of bristles on typical terga with about five to seven bristles per side, terminating well above spiracle; second row of bristles extending to or slightly below level of spiracle. Typical sterna in male with three or four subventral bristles per side, preceded by two to four smaller ones; in female with a row of five to seven bristles preceded by four to six smaller bristles in one or two ventromarginal rows. Antesensiliary (antepygidial) bristles as follows: one long bristle in male; in female either three or four long bristles, of which upper two are slightly the longer.

Modified abdominal segments, male (Fig. 5).—Eighth tergum (*8T.* and Fig. 3) very large and enclosing most of genitalia, as is typical for subfamily; with a dorsomarginal row of bristles of increasing size extending to just short of midpoint; remainder of dorsal region lacking bristles; with a closely appressed group of five submarginal bristles near ventrocaudal angle; and with three long lateral or subdorsal bristles. Eighth sternum (*8S.*) dorso-apically produced into a long semimembranous filamentous flap or projection as long or longer than rest of segment; apically minutely frayed; tufted; with a long, conspicuous ventromarginal bristle at origin of above long narrow flap; sclerotized portion of segment, as measured from base to insertion of long bristle, more than five times as long as broad at midpoint—at base the ratio is three to one. With a frayed or spiculose semimembranous intersegmental process (*I.M.*) between eighth and ninth sterna. Immovable process of clasper (*P.* and Fig. 8) a long, thumb-like projection, with three small apical bristles. Acetabular bristle (*AC.B.*) inserted on a subacute convexity at a level slightly below midpoint of caudal margin of *P.* Movable finger or digitoid (*F.*) very large, essentially roughly cleaver-shaped; anterior and dorsal margins fairly straight; posterior margin angled and somewhat hooked, producing apparent caudal and ventral margins—of these, caudal margin mildly undulate and running slightly obliquely to anterior margin; ventral margin twice as long as dorsal margin, sinuate, with anterior half convex, posterior half concave. *F.* somewhat more than half as broad at midpoint as long at maximum point; with two heavy stout bristles at dorsocaudal angle; with a subspiniform at hook of ventrocaudal angle; immediately above this another marginal spiniform; a third such subspiniform inserted at ventral third of caudal margin. Manubrium (*MB.*) broad but apically acuminate. Ninth sternum with proximal arm (*P.A.9*) narrow, subapically upturned and then straightening so that apical portion is somewhat beak-shaped. Distal arm of ninth sternum (fig. 11) as long as proximal arm; its apical two-thirds modified along the ventral margin as follows: a conspicuous, ovate proximal lobe (*PR.L.*) which bears three short stout bayonet-shaped marginal bristles; immediately above and laterad to proximal lobe a peculiar broad subacute, downward-directed secondary lobe (*SY.L.*) which is devoid of bristles; distally expanded to form a long ovate apical lobe (*AP.L.*) which bears about 12 to 15 marginal bristles. In addition, distal arm with scattered thin bristles on apical lobe and two such dorsomarginal bristles; with about six ventromarginal thin bristles between secondary lobe and apical lobe.

Aedeagal apodeme (*AE.A.*) relatively narrow, about eight times as long as broad, as measured from the middle of the constricted neck (*N.*) to the short acuminate apical appendage (*AP.A.*); with a long, well-developed proximal spur (*P.S.*). Aedeagal endchamber (Fig. 10) characterized by the well-developed lateral lobes (*L.L.*) which are produced into conspicuous acuminate cephalad-directed flaps anterior to proximal lobe (*PR.L.*) of *D.A.9.* Median dorsal lobe (*M.D.L.*) slightly sinuate, heavily sclerotized where it turns straight ventrad at apex of inner tube. Crochets (*CR.*) quite long, about twice as long as broad but weakly sclerotized so that its outlines are difficult to see; caudal margin fairly well sclerotized, concave; ventral margin straight for about two-thirds its length, then curving upwards towards point of insertion; the peg-like sclerotization, characteristic of the crochet of ceratophyllid fleas, undeveloped, inconspicuous. Sclerotized inner tube (*S.I.T.*) short, bearing a prominent dorsoproximal thumb-like armature (*A.I.T.*) and with its apex (*A.S.I.*) produced upwards as a narrow spur. With sclerotized narrow band of inner tube (*B.I.T.*) extending distad of *S.I.T.* Lateral sclerotization of inner tube (*L.S.I.*) rather prominent. Crescent sclerite (*C.S.*) overlying apodemal strut, which is of the usual type. Sensilium (*SN.*) very flat, with about 15 pits per side. Dorsal lobe of proctiger (*D.A.L.*) an isosceles triangle lying on its side; with a dorsal row of bristles; ventral lobe of proctiger longer and narrower, with an apical tuft of bristles.

Modified abdominal segments, female (Fig. 6).—Seventh sternum (*7S.*) with a shallow broad sinus on caudal margin. Lobes above sinus evenly rounded; with an irregular oblique row of about



FIGS. 9–11.—*Hollandipsylla neali*, n. gen., n. sp.: 9, Thorax; 10, end chamber of aedeagus; 11, distal arm of ninth sterum, male

eight fairly long bristles which merges with a ventromarginal row of approximately eight; with a row of three or four smaller bristles preceding the oblique row; in addition, with about five or six small ventromarginal bristles. Eighth tergum (*8T.*) with four or five bristles below sensilium five or six caudomarginal bristles below ventral anal lobe (*V.A.L.*) and a lateral and subventral group of about 13 bristles, two or three of which are submarginal; in addition, with three short mesal bristles below ventral anal lobe. Eighth sternum (*8S.*) lightly sclerotized, devoid of bristles. Dorsal anal lobe of proctiger with a row of marginal bristles and about 10 to 12 scattered lateral or lateromedian bristles; in addition, with five marginal bristles below anal stylet (*A.S.*). Anal stylet (Fig. 2) about three times as long as broad at base; with a very long apical bristle and a long ventromarginal bristle; with a tiny dorso-apical bristle. Ventral anal lobe (*V.A.L.*) almost evenly curved, not conspicuously angled. Spermatheca (*SP.* and Fig. 7) somewhat deformed in specimen extant but the head more than twice as long as broad; dorsal margin somewhat convex, ventral margin almost straight, with tail apparently recurved over head and much shorter than head. Bursa copulatrix (*B.C.*) subglobose, its duct slightly curved, short; with a narrow blind duct narrower than but more than twice as long as *ductus bursae*.

This species is named for Dr. William Neal, director of the Medical Services in North Borneo, who rendered great assistance to the Medical Research Units working in the field in North Borneo.

Comment.—Eyeless fleas are either parasites of typically subterranean or wholly nocturnal hosts, or else are forms that are characteristic inhabitants of rodent nests and modified accordingly (*1*, *2*). The nest inhabitants are rarely found on the hosts themselves and apparently feed while the mammal or bird is sleeping. Such species of fleas typically possess elongate mouthparts and reduced chaetotaxy, including reduction in the size and/or number of spines of the genal and other combs (*3*). In the description of *Ceratophyllus arcuegens*, collected from the nest of cliff swallows, Holland (*4*) points out that this species is evidently rather sedentary, "as indicated by the rather large and deep abdomen as well as by some reduction of the legs and thorax." *C. arcuegens* lacks the pleural arch, a socket arrangement or "head" capping the pleural ridge. Certain other nest-fleas also lack a pleural arch, e.g., *Anomiopsyllus* Baker, 1904, *Megarthroglossus* Jordan and Rothschild, 1915, *Conorhinopsylla* Stewart, 1930, *Stenistomera* Rothschild, 1915, and *Wenzella* Traub, 1953. The pleural arch is also absent in some squirrel fleas, i.e., *Hollandipsylla* gen. nov., and, as pointed out by Traub (*5*), *Syngenopsyllus* Traub, 1950, *Tarsopsylla* Wagner, 1927, *Libyastus* Jordan, 1936, *Myoxopsylla* Wagner, 1927, *Brachyctenonotus* Wagner, 1929 and the fleas of the genus *Opisodasys* Jordan, 1933, which parasitize flying squirrels (*O. pseudarctomys* (Baker, 1904) and *O. vesperalis* (Jordan, 1929)). These squirrel fleas are relatively rare in collections even though their true hosts are fairly frequently encountered. Some (i.e., *Tarsopsylla*) have been found to be rather abundant in the nest of the host, but too little is known of the habits of these fleas to indicate whether such occurrence is the rule. The long labial palpi (i.e., *Syngenopsyllus*), the elongate legs (i.e., *Tarsopsylla*) and reduction in the size of the spines of the pronotal comb (i.e., *Brachyctenonotus*) in this group of fleas indicate that the squirrel fleas lacking the pleural arch may also be nest-inhabiting species. A pleural ridge of this type may therefore be an important structural modification of nest-fleas, and may be associated with the corresponding sedentary habits, as Holland suggests in the case of *Ceratophyllus arcuegens*.

Our current knowledge of the habits of *Hollandipsylla* are insufficient for us to determine whether the reduction of the eye is correlated with nest-inhabitation or with the nocturnal or crepuscular nature of the host, a flying squirrel. It is interesting, however, that reduced or vestigial eyes occur in unrelated fleas which parasitize subterranean or nocturnal hosts. Thus *Foxella* Wagner, 1929, and *Dactylopsylla* Jordan, 1929 (Ceratophyllidae), are parasites of American pocket gophers. *Pulex sinoculus* Traub, 1950 (Pulicidae), an eyeless species closely related to *P. irritans*, was collected on Guatemalan pocket gophers. The eyeless flea of the Cape dune mole, *Bathyergus maritimus*, is *Cryptoctenopsyllus ingens* (Rothschild, 1900) which is essentially a combless *Dinopsyllus* (Dinopsyllinae, Hystrichopsyllidae). Among the primarily nocturnal or crepuscular animals which carry fleas with reduced eyes are bats, parasitized by fleas in a distinct family, Ischnopsyllidae, and shrews (i.e., *Blarina*, *Sorex*) which are typically parasitized in North

America by *Doratopsylla* Jordan and Rothschild, 1912, and *Corrodopsylla* Wagner, 1929 (Ctenophthalminae, Hystrichopsyllidae). It should be pointed out that the above correlation is by no means perfect. In fact, the converse is apparently also significantly true. Certain nocturnal mammals have adapted themselves to their dim environment by developing enlarged eyes. The flying squirrels, the slow lorises (*Nycticebus*), and the tarsier are in this category. Certain fleas have apparently paralleled this development. Thus, some *Xenopsylla* occurring on nocturnal rodents in the desert have unusually large eyes. Other *Xenopsylla*, associated with similar hosts, have reduced eyes (e.g., *Xenopsylla crinita* Jordan and Rothschild, 1922), while the genus *Rooseveltiella* C. Fox, 1914, was established for a species occurring on the Cape mole rat, *Georychus*, or a similar burrowing mole-like animal, is actually an eyeless *Xenopsylla*.

Summary.—Hollandipsylla neali, a new genus and species of flea from a North Borneo flying squirrel, is described and illustrated in detail. It is unique among squirrel fleas of the subfamily Ceratophyllinae in being eyeless and in possessing only three pairs of lateral plantar bristles on the last segment of the tarsi, two proximal pairs being displaced mesad. Included is a discussion of species of fleas which are characteristic inhabitants of the nests of the hosts. It is pointed out that such fleas usually have elongate labial palpi and legs and are further characterized by a reduction of the eyes and in chaetotaxy and in the development of the thorax. Loss of the pleural arch of the thorax is common. It is pointed out that fleas which parasitize subterranean or nocturnal hosts usually have reduced or vestigial eyes, regardless of the true affinities of the flea species involved.

LIST OF ABBREVIATIONS

A.B.	Antesensiliary bristle.
AC.B.	Acetabular bristle.
AE.A.	Aedeagal apodeme.
AP.A.	Apical appendage of aedeagal apodeme.
AP.L.	Apical lobe of ninth sternum.
A.L.L.	Accessory lateral lobe.
AP.R.9	Apodemal rod of ninth sternum.
A.I.T.	Armature of inner tube.
A.S.	Anal stylet.
A.S.I.	Apex of sclerotized inner tube.
B.C.	Bursa copulatrix.
B.I.T.	Sclerotized band of inner tube.
CR.	Crochet.
C.S.	Crescent sclerite.
D.A.L.	Dorsal anal lobe of proctiger.
D.A.9	Distal arm of ninth sternum.
F.	Movable finger or digitoid of clasper.
I.M.	Intersegmental membrane.
L.L.	Lateral lobe of aedeagus.
L.M.	Lateral metanotal area.
L.S.I.	Lateral sclerotization of inner tube.
MB.	Manubrium.
M.D.L.	Median dorsal lobe of aedeagus.
MPM.	Mesepimere.
MPS.	Mesepisternum
MSN.	Mesonotum.
MTM.	Metepimere.
MTN.	Metanotum.
MTS.	Metepisternum.
N.	Neck or constriction of aedeagus.
P.	Immovable process of clasper.
P.A.9	Proximal arm of male ninth sternum.
P.R.	Penis rod.
PR.L.	Proximal lobe of distal arm of ninth sternum.
P.S.	Proximal spur of aedeagus.
PS.S.	Pseudosetae.
S.I.T.	Sclerotized inner tube of aedeagus.
SN.	Sensilium.
SP.	Spermatheca.
S.S.	Subpygidial sclerite.
SY.L.	Secondary proximal lobe of D.A.9.
7S.	Seventh sternum.
8S.	Eighth sternum.
7SPR.	Seventh spiracle.
8SPR.	Eighth spiracle.
1T.	First tergum.
7T.	Seventh tergum.
8T.	Eighth tergum.
V.A.L.	Ventral anal lobe.
VC.1	First vinculum, or link plate.
X.G.	So-called X-gland of Wagner.

REFERENCES

(1) TRAUB, R. Johnsonaepsylla audyi, *a new genus and new species of flea from North Borneo, with notes on the subfamily Leptopsyllinae (Siphonaptera)*. Journ. Washington Acad. Sci. **42**(9): 288–296, 9 figs. 1952.

(2) TRAUB, R. *Siphonaptera from Central America and Mexico, a morphological study of the aedeagus, with descriptions of new genera and species*. Zool. Mem. Chicago Nat. Hist. Mus. **1**(1): 1–127, 54 pls. 1950.

(3) TRAUB, R., AND TIPTON, V. J. Jordanopsylla allredi, *a new genus and species of flea from Utah (Siphonaptera)*. Journ. Washington Acad. Sci. **41**(8): 264–270, 7 figs. 1951.

(4) HOLLAND, G. P. *Descriptions of fleas from northern Canada*. Can. Ent. **84**(10): 297–308, 25 figs. 1952.

(5) TRAUB, R. *Notes on Indo-Malayane fleas, with descriptions of new species (Siphonaptera)*. Proc. Ent. Soc. Washington **52**(3): 109–143, 64 figs. 1950.

ENTOMOLOGY. *A new species of* Culex *from the Marquesas Islands and the larva of* Culex atriceps *Edwards* (Diptera: Culicidae).

ALAN STONE, U. S. Bureau of Entomology and Plant Quarantine, and LEON ROSEN, National Microbiological Institute.

In the course of mosquito surveys conducted in connection with filariasis studies on the six inhabited Marquesas Islands, the junior author found an apparently undescribed indigenous species of *Culex*, which is herein described. Because of similarity of this species to *Culex atriceps* Edwards, which is known only from the Society Islands, a description of the heretofore undescribed larva of the latter species is also given. The drawings are by Sally Kaicher.

Culex marquesensis, n. sp.

Figs. 1, A–C; 2, A–B

Male.—Length of body 3.5 mm. Vertex with curved decumbent yellowish-white scales centrally, these broader and more abundant on sides; centrally with numerous erect, forked, dark-brown scales. Palpus dark brown, the last two segments and apical part of the third with long unmodified hairs. Proboscis extending to middle of fourth palpal segment, entirely dark brown except for the yellowish labellae. Torus yellow; antenna not as long as proboscis. Scales of anterior pronotal lobe, posterior pronotum, scutum, and scutellum pale yellowish to brown; integument of scutum brown with a pair of straight central and a pair of curved lateral stripes of paler color in the usual pattern. Postscutellum pale. Thoracic setae brown. Pleuron greenish yellow, sometimes faintly mottled with darker; a few scattered flat pale scales on pleuron. One or two lower mesepimeral setae. Scales of wing dark; knob of halter dark, with dark scales. Legs entirely dark scaled except for paler posterior surfaces of the femora. Dorsum of abdomen dark scaled, with basal bands of pale scales on tergites 2–6, that on 2 slightly separated from base by an unscaled area; venter likewise banded, the pale basal bands often broader. Terminalia: Basistyle nearly three times as long as broad, without scales, but with long hairs dorsally and laterally; subapical lobe slightly beyond middle, divided into two parts, the ventral portion a short lobe bearing three stout, parallel filaments, the two distal ones hooked at tips, the third shorter and straight; inner (more dorsal) portion a short cone with a single straight, tapering filament; between these a striated leaf and distad of this leaf a single slender hair on a tubercle. Dististyle broad and flattened, the end abruptly tapering with a short distal spine. Dorsal arms of mesosome straight, untoothed, slightly divergent; ventral arms a mass of curved teeth; tenth sternites distally with a mass of tapering spines; lateral arms broad, blunt, curved ventrally. Ninth tergite forming a broad V, weakly haired.

Female.—Coloration essentially as in male, but scales generally slightly darker and pale areas of posterior surfaces of femora usually restricted to basal halves on mid and hind femora; pale abdominal bands narrow, the hind margins straight. Palpus about one-sixth length of proboscis.

Larva.[1] Head: Length three-fourths of width; color yellow, usually with a dark band across frontal hair area. Antenna smooth, short, its length slightly more than one-third distance between bases of antennae, cylindrical, about six times as long as thick, not tapering; shaft hair usually triple, at middle of antenna and reaching about to apex. Clypeal spine moderately stout, curved; outer clypeal hair small, no postclypeal hair; inner frontal hairs single, widely separated, placed behind level of antennal bases; midfrontal hairs single, long, directly in front of inner frontals and in front of level of antennal bases; outer frontal hairs usually triple, directly above or slightly anterior to base of antenna. Mental plate subtriangular, the sides convex, with about eight teeth on each side.

Thorax: Integument smooth; prothoracic hair 0 very small, double; 1–3 on one tubercle, all single, 1 longest, 3 shortest; 4 single, halfway between shoulder hairs and hair 5; 5–7 close together, 5 and 6 single, 7 double; hair 8 small, single; hairs 9, 10, and 12 long, simple; 11 very small, double; 14 small, single.

Abdomen: Segments III–VI each with only one large lateral hair, 3- to 5-branched. Segment

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[1] The nomenclature of the larval chaetotaxy used here is that of Belkin (1950).

VIII with pentad hair 1 3- to 9-branched; 2 single and very close to 1; 3 7- to 10-branched; 4 single; 5 2- to 4-branched. Comb scales 21 to 26 in a triangular patch, each scale broadened apically with an even fringe of hairs. Air tube three times as long as broad, only slightly tapering at distal third; acus well developed. Siphonal hairs 4 or 5 in each of two straight, widely separated rows, each hair about as long as width of siphon, multiple, the first at basal fifth to third, the last at about apical third. Pecten of 6 to 11 teeth, each with 5 slender, deep, serrations. Anal segment ringed by the saddle, the ventral half abruptly narrowed to about one-half the length of the dorsal half. Only very minute spines dorsally at apex. Lateral hair of saddle very small, 4- to 5-branched. Inner dorsal hair with about 5 long branches, outer dorsal hair long, single. Anal gills four, rather stout, the dorsal pair about twice as long as dorsal length of saddle, the ventral pair about three-fourths as long as dorsal pair. Ventral brush of about 12 tufts.

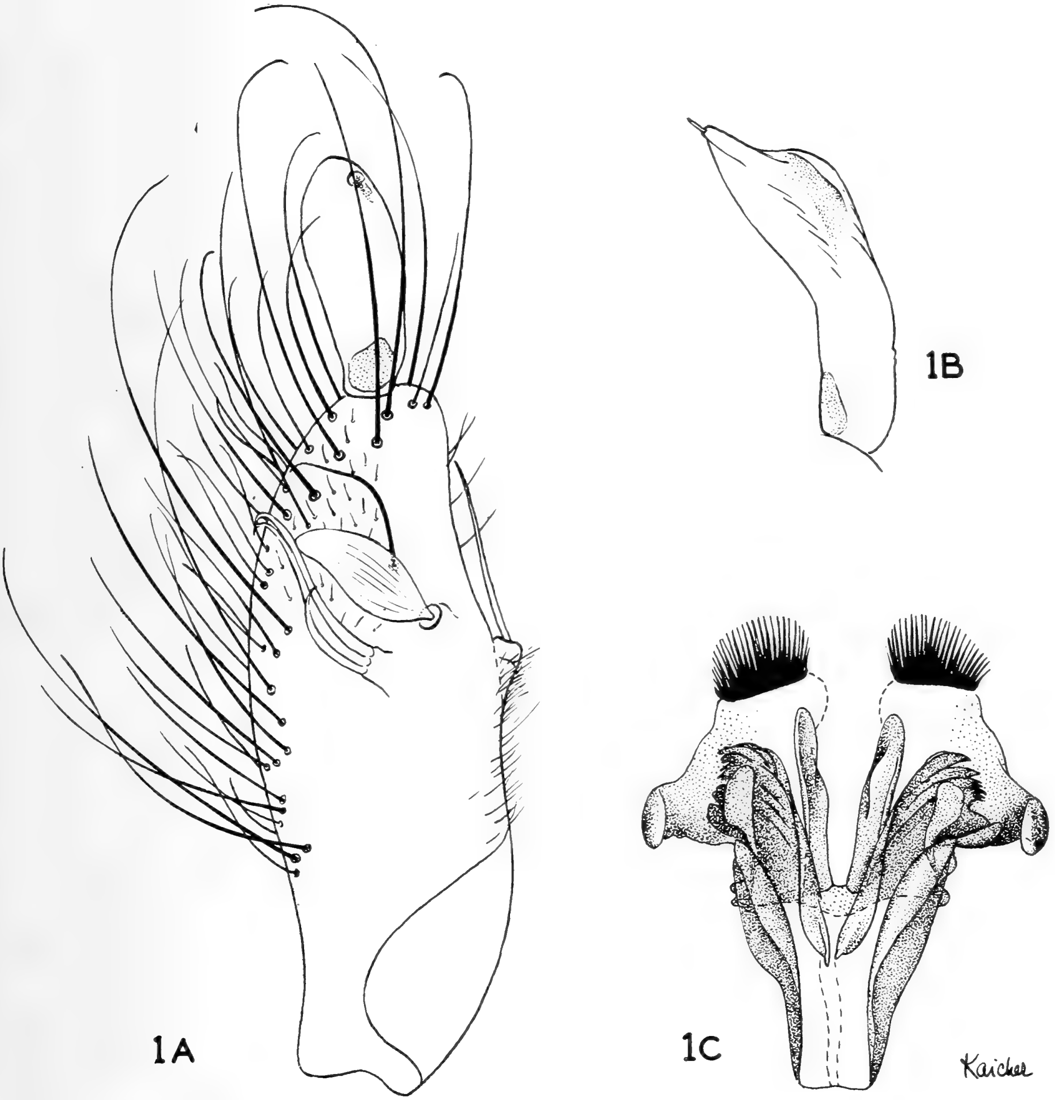


Fig. 1.—*Culex marquesensis*, n. sp.: A, Basistyle and dististyle of male, ventral view; B, dististyle, lateral view; C, mesosome and tenth sternites, dorsal view.

Holotype.—Male, ex barrel top, Atuona Bay, Hivaoa, Marquesas Islands, June 12, 1952 (Leon Rosen) with genitalia and larval and pupal exuviae on slide. Paratypes, same data, 182 males and females. Holotype and paratypes (U. S. National Museum no. 61839); paratypes, British Museum, Paris Museum, California Academy of Sciences, Bishop Museum, School of Hygiene and Public Health of the Johns Hopkins University, and South Pacific Commission, Noumea, New Caledonia. Additional specimens were collected on Nukuhiva (Taiohae and Tiapivai Bays), Uapou (Hakamaii Bay), Uahuka (Vaipae and Hokatu Bays), and Tahuata (Hapatoni Bay).

This species shows no close relationship to any described Pacific species other than *Culex atriceps* of the Society Islands. Both of these species appear to fall into Edwards' *decens* series, of the *pipiens* group of the typical subgenus *Culex*. This is an African group, in which the proboscis and tarsi are all dark, the abdominal tergites usually have only basal lateral pale spots, and the male palpi are usually without any white line on the lower surface of the last two segments. The terminalia of *marquesensis* are rather similar to those of several of the *decens* series. Edwards noted that the larvae of this series show great variation, a condition further developed if both *atriceps* and *marquesensis* are included.

Although *marquesensis* is not closely related to *C. quinquefasciatus*, the only other known *Culex* in the Marquesas, it could be confused with it by superficial examination. The best external characters to distinguish the adult of *marquesensis* are the yellow labellae, strongly contrasted with the dark proboscis, and the uniformly dark brown scaling of the mesoscutum. In *quinquefasciatus* the labellae may be somewhat paler but never as strongly contrasted, and the mesonotal scales are distinctly tinged with yellow or orange. The single inner and midfrontal hairs of the larva of *marquesensis* readily distinguishes this stage.

Biology.—The larvae of *marquesensis* have been found in the following types of breeding places: water drums, rock holes, coconut husks, and barrel tops. They have been found in association with both *Aedes polynesiensis* Marks and *Culex quinquefasciatus* Say. The adults of *marquesensis* were not found in nature.

Two other species of mosquitoes, *A. polynesiensis* (formerly known as *A. pseudoscutellaris*) and *C. quinquefasciatus*, have previously been reported from several of the Marquesas Islands. (Marks 1951) New distribution records from the recent surveys are as follows: *A. polynesiensis*—Uapou; *C. quinquefasciatus*—Uapou, Uahuka, and Nukuhiva. Both *A. polynesiensis* and *C. quinquefasciatus* have now been found on all six inhabited islands of the group and *C. marquesensis* has been found on five of these six islands.

Culex atriceps Edwards

Fig. 3, A–B

Bull. Ent. Res. **17:** 105, 1926. Type locality, Papeari, Tahiti.

Larva.—Head: Length about three-fourths width; yellowish, weakly darkened on the disk posteriorly and a darker spot behind but separated from eye. Antenna sparsely spiculate, short, its length about one-third distance between bases of antennae, cylindrical, about eight times as long as diameter, slightly narrowed beyond shaft hair, which is slightly beyond middle of antenna, multiple. Clypeal spines slender, curved; outer clypeal hair small; post clypeal hairs very small, double, about on line of midfrontal hairs; frontal hairs distinctly plumose; inner frontal hair 5- to 8-branched, well behind level of bases of antennae; midfrontal hair 4- to 6-branched, near inner frontal hair and on line between inner and outer frontals; outer frontal hair 7- to 11-branched near to, but slightly posterior to antennal bases. Mental plate subtriangular, with a very strong, prominent median tooth and 10 to 11 lateral teeth, the 7th and 8th from apex being largest.

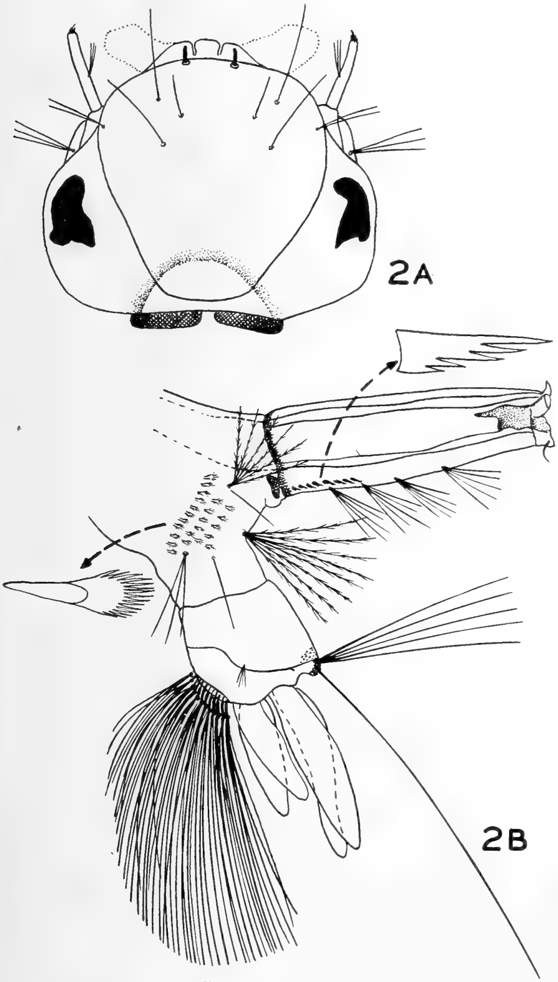
Thorax: Integument smooth. Prothoracic hair 0 small, multiple; 1 to 3 on one tubercle, all single, subequal; 4 double; 5 and 6 rather close together, single; 7 more distant, double; 8 rather small, single; prothoracic pleural group with one long simple hair, two much shorter and finer, and a much smaller one 4-branched; 14 small, single or double.

Abdomen: Segments III to VI with one long lateral hair, 2- or 3-branched. Segment VIII with pentad hair 1 3- to 5-branched, 2 single and close to 1, 3 7- to 9-branched, 4 single, 5 usually 2-branched. Comb scales 30 to 40 in a triangular patch, each scale broadened apically with an even fringe of hairs. Air tube 3 to 3.5 times as long as basal width, rather evenly tapered to apex; acus well developed. About six pairs of siphonal tufts rather irregularly arranged on the median three-fifths of the siphon ventrally, none of the hairs displaced to the side; tufts mostly longer than width of siphon at point of insertion, except for the small apical pair. Pecten of 10 to 20 teeth extending to or somewhat beyond middle of siphon; each tooth usually with 2, 3, or rarely 4, serrations. Anal segment ringed by the saddle, the ventral length about two-thirds dorsal length; lateral hair small, single, or rarely, double. A patch of rather large spines on the saddle at apex to each side of dorsal hairs. Inner dorsal hair 11- to 14-branched; outer dorsal hair long, usually single, rarely double. Anal gills 4, rather stout, subequal, from about length of anal segment to more than twice length of saddle. Ventral brush of 11 or 12 tufts.

This description is drawn from specimens collected by the junior author from a tree hole at Paoa, Tahiti, January 2, 1952, and from the exuviae of reared specimens from a coconut husk at Vairao, Tahiti, May 8, 1952.

The forward position of the multiple head hairs and the length of the pecten are characteristic of the larva of this species. A closely related larva was collected from *Pandanus* axils on Tahiti but no adults were reared. It does not seem advisable to describe this species until adults can be associated.

Biology.—The larvae of *C. atriceps* have been found on the islands of Tahiti and Moorea



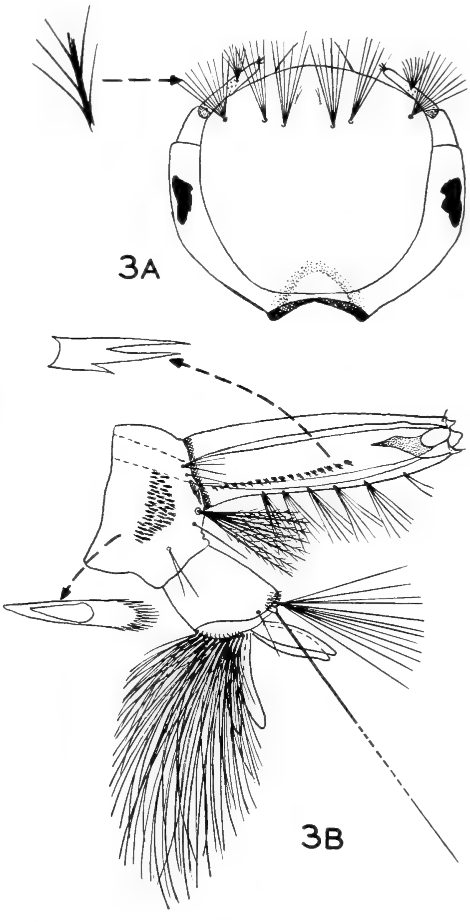


Fig. 2.—*Culex marquesensis,* n. sp.: A, Head of Larva; B, end of abdomen of larva.
Fig. 3.—*Culex atriceps* Edwards: A, Head of larva; B, end of abdomen of larva.

(Society Islands) in the following types of breeding places: tree holes, coconut husks, and various types of artificial containers. The larvae are frequently found in association with those of *A. polynesiensis*. The adults have been observed to attack man at night, but rarely in considerable numbers. They are sometimes seen resting in houses but are more commonly found in natural resting places such as tree buttresses.

The junior author has shown that occasional specimens of the species are capable of allowing complete development of Polynesian strains of *Wuchereria bancrofti*. *C. atriceps* would not seem to be an important vector of this parasite in nature because of its inefficiency as a host and the rarity with which it attacks man.

LITERATURE CITED

BELKIN, JOHN N. *A revised nomenclature for the chaetotaxy of the mosquito larva (Diptera: Culicidae)*. Amer. Midland Nat. **44**(3): 678–698. 1950.

MARKS, ELIZABETH N. *Mosquitoes from southeastern Polynesia*. Occ. Pap. Bernice P. Bishop Mus. **20**(9): 23–30. 1951.

ENTOMOLOGY.—Laelaps oryzomydis, *n. sp., with a key to some American species of* Laelaps (Acarina: Laelaptidae). H. D. PRATT and JOHN E. LANE,[1] U. S. Public Health Service, Atlanta, Ga.

A new species of mite in the genus *Laelaps* has been collected in several States in southeastern United States. The species name **oryzomydis** here assigned to it refers to the fact that the type series was collected on rice rats (*Oryzomys palustris*).

Female (Fig. 1).—Length, exclusive of gnathosoma, about 0.6 mm, width about 0.4 mm. Chelicera with basal segment about as long as apical segment without chelae, fixed chela with two fine teeth and a seta, and movable chela with two teeth opposite seta of fixed chela. Jugularia absent but a differentiated jugular area present which extends across the sternal plate. Sternal plate widest between coxae II and III, posterior margin moderately, irregularly concave, anterolateral corners pointed, the usual six setae present with slightly expanded sternal pores behind the four anterior setae. Endopodal plates distinct and small. Genito-ventral plate with anterior margin faintly striate, strongly expanded behind fourth coxae, bearing four pairs of setae which are longer than the interval between adjacent setae. Anal plate similar in shape to that in *Haemolaelaps glasgowi* (Ewing), the anterolateral corners rounded, anus about three-fourths its length from the anterior margin of anal plate, the paired setae tangential to posterior margin of anus and distinctly more slender than the posterior seta. Coxa I has the internal spine distinctly stouter than the external spine; coxa II has a slender anterior and stout posterior spine; coxa III has a long slender anterior and stout, short, posterior spine; coxa IV has a single minute seta near the coxaltrochanteral articulation. Dorsal shield nearly covering dorsal surface, the majority of the seta almost as long and strong as those on the genito-ventral plate.

Laelaps oryzomydis is closest to *Laelaps nuttalli* Hirst, which is collected in large numbers by workers of the U. S. Public Health Service Typhus Control Program. It differs from this last species in having the internal spine on the forecoxa stouter than the external spine, while the reverse is true in *nuttalli*. The anal plate is more triangular in *nutalli* than in *oryzomydis*. The two setae on the posterior margin of the genito-ventral plate are more widely separated in *nuttalli*, being tangential with the anterior corners of the anal plate, while in *oryzomydis* these setae are placed closer together, being definitely median to the corners of the anal plate. There are expanded pores behind the two anterior and two middle setae on the sternal plate in *oryzomydis*. These are reduced and slit-like in *nuttalli*.

Male.—About 0.5 mm long. Very similar to other male *Laelaps*. It falls in the group having the sternal, genitoventral, and anal plates all fused into one arrowhead-shaped holoventral plate and the dorsal plate with long, slender

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[1] The writers wish to acknowledge the constructive criticism of Dr. E. W. Baker, of the U. S. Bureau of Entomology and Plant Quarantine, during the preparation of this paper. They are also grateful to Drs. S. W. Simmons, H. P. Nicholson, and C. M. Tarzwell, of the Technology Branch of the Communicable Disease Center, and B. A. Barrington and C. B. Worth, who made available these collections of ectoparasites upon which the new species is based.

setae. Chelicera with chelae long and slender, smooth, apparently twice as long as the segment which bears them. The second and fourth tarsi with slender setae, peritreme extending to middle of coxa II.

Holotype.—Female, Jasper County, S. C., December 8, 1948, H. P. Nicholson. Collected from rice rat (*Oryzomys palustris palustris* (Harlan)). U. S. National Museum no. 2073.

Allotype.—Male, same data as above, in the U. S. National Museum.

Paratypes.—Tampa, Fla., March 1949, C. B. Worth, host *Oryzomys palustris natator* Chapman, 8 paratype females; Gainesville, Fla., November 17, 1946, B. A. Barrington, host *Oryzomys palustris natator* Chapman, 8 paratype females; Jasper County, S. C., from March 5 to December 10, 1948, all on *Oryzomys palustris palustris* (Harlan), 50 paratype females mounted on slides.

Holotype, allotype, and paratypes in the U. S. National Museum collection. Paratypes in the U. S. Public Health Service, Communicable Disease Center collection, Atlanta, Ga.; Rocky Mountain Laboratory at Hamilton, Mont.; and Western Communicable Disease Center Laboratory, San Francisco, Calif.; Texas State Department of Health collection, Austin, Tex.; and the private collection of Dr. R. W. Strandtmann, Lubbock, Tex.

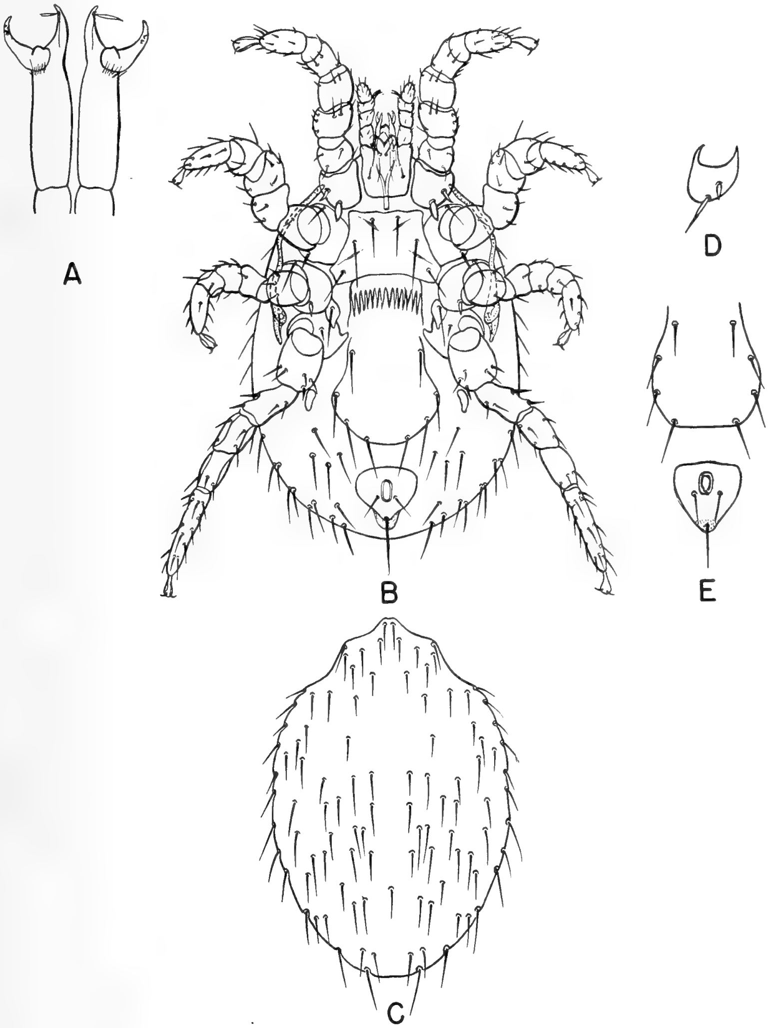


FIG. 1.—A–C, *Laelaps oryzomydis*, n. sp.: A, Chelicerae; B, ventral aspect of female; C, dorsal plate of female. D, E, *Laelaps nuttalli* Hirst: D, Forecoxa of female; E, genitoventral and anal plate of female.

This species probably breeds throughout the year on rice rats, various subspecies of *Oryzomys palustris*. The biggest collection, from Jasper County, S. C., game refuge, contained at least 46 *Laelaps oryzomydis*. The rice-rat louse (*Hoplopleura oryzomydis* Pratt and Lane) and the following mites were also found in collections from rice rats: *Gigantolaelaps cricetidarum* Morlan, *Haemolaelaps glasgowi* (Ewing), *Haemolaelaps megaventralis* Strandtmann, *Bdellonyssus* species near *bacoti*, *Androlaelaps* species, and often hundreds of mites of the family Listrophoridae on a single rice rat. The cotton-rat flea (*Polygenis gwyni* (C. Fox)) was also found in these same collections.

The following keys to male and female *Laelaps* are modified from those of Grant (1947):

A KEY TO SOME SPECIES OF MALE NORTH AMERICAN LAELAPS

1. Dorsal plate with long, hairlike setae; sternal, genitoventral, and anal plates all united into a single holoventral plate 2
   Dorsal plate with short, spiniform setae; sternal and genitoventral plates united, but separate from anal plate 5
2. Second tarsus with some short curved spiniform setae near tips (on microtine mice)
   L. alaskensis Grant
   Second tarsus without curved spiniform setae, all straight 3
3. Peritreme tube extending to coxa II; second tarsus with slender setae only (on rice rats, genus *Oryzomys*) . . . . *L. oryzomydis*, n.sp.
   Peritreme tube extending forward beyond coxa II; second tarsus with some stout setae 4
4. Larger species at least 0.9 mm long (on domestic rats, genus *Rattus*) . . *L. echidninus* Berlese
   Smaller species 0.5 to 0.8 mm long (on domestic rats, genus *Rattus*) . . . . *L. nuttalli* Hirst
5. United sternal and genitoventral plate widely separated from the anal plate and with posterior border slightly concave (on microtine mice) . . . . *L. kochi* Oudemans
   United sternal and genitoventral plate with posterior border proximal to the anal plate (on muskrats, genus *Ondatra*)
   L. multispinosus Banks

A KEY TO SOME SPECIES OF FEMALE NORTH AMERICAN LAELAPS

1. Anal plate contiguous with genitoventral plate and fitting into a strong concavity in genitoventral plate (on domestic rats in genus *Rattus*) . . . . *L. echidninus* Berlese
   Anal plate separated from genitoventral plate, which is usually convex or straight on posterior margin, not strongly concave 2
2. Dorsal setae long and slender 3
   Dorsal setae small and short 5
3. Internal spine on forecoxa distinctly stouter than external spine (on rice rats in genus *Oryzomys*) . . . . *L. oryzomydis*, n.sp.
   Internal spine on forecoxa more slender than external spine 4
4. Genitoventral plate widely separated from anal plate; anal plate with anterior margin rounded (on microtine mice)
   L. alaskensis Grant
   Genitoventral plate extending posteriorly almost to anal plate; anal plate with anterior margin truncate and definite angular anterolateral corners (on domestic rats in genus *Rattus*) . . . . *L. nuttalli* Hirst
5. Anal plate subtriangular; posterior border of sternal plate deeply arched; coxal spines not greatly enlarged basally (on microtine mice) . . . . *L. kochi* (Oudemans)
   Anal plate suboval; posterior border of sternal plate poorly defined, not greatly arched; coxal spines greatly enlarged basally (on muskrats of genus *Ondatra*)
   L. multispinosus Banks

REFERENCES

Grant, C. Donald. *North American mites of the genus* Laelaps (*Arachnida: Acarina: Parasitidae*). Microentomology **12**(1): 1–21. 1947.

Hirst, S. *On the parasitic acari found on the species of rodents frequenting human habitations in Egypt*. Bull. Ent. Res. **5**(3): 215–229. 1914.

ZOOLOGY.—*Two new semiparasitic harpacticoid copepods from the coast of New Hampshire.*

Arthur G. Humes, Department of Biology, Boston University. (Communicated by Fenner A. Chace, Jr.)

Two new species of semiparasitic harpacticoid copepods were found in the summer of 1952 during routine classroom study of living invertebrates at the University of New Hampshire. One, belonging to the genus *Nitocra* Boeck (Ameiridae), inhabited small pits in the exumbrellar surface of a scyphozoan medusa. The other, a memebr of the genus *Mesamphiascus* Nicholls (Diosaccidae), occurred on the first maxillipeds of the American lobster.

Nitocra medusaea, n. sp.

Approximately 1,030 individuals of this copepod were discovered on the exumbrellar surface of a living medusa of an unidentified species of *Aurelia*, about 3 inches in diameter, collected by Dr. Mary D. Rogick on July 17, 1952, off Fort Stark, in the harbor of Portsmouth, N. H. When undisturbed, the copepods remained in flask-shaped pits in the exumbrella, the largest pit being about 1–1.5 mm deep and 1 mm in diameter. There were more than thirty pits on this medusa, each with 10–30 or more copepods. Since the bodies of the copepods massed together in the pits were opaque or slightly cream-colored, the medusa appeared to the unaided eye as though there were sand grains embedded in the jelly. One might presume that the pits resulted from the presence of the copepods, but whether or not the copepods excavate the pits is not known. When examined under intense illumination or when disturbed with a needle, the copepods became active and crawled in and out of the pits and over the exumbrellar surface, clinging tenaciously to bits of debris and jelly fragments.

The type material consists of more than 1,000 individuals, representing both sexes. The holotype female (No. 95305), allotype (No. 95306), and paratypes (300 females and 100 males, No. 95307) have been deposited in the United States National Museum. Other paratypes are in the author's collection.

Female.—In life the body (Fig. 1) is transparent, without distinct color. The eye is bright red. The total length (measuring from the tip of the rostrum to the posterior end of the caudal rami), based on five specimens, is 0.79 mm (0.75–0.82 mm). The ratio of length of the head (plus rostrum) and the first five leg-bearing thoracic segments to the genital segment and abdomen (plus caudal rami) is 49:30. The genital segment has a slight indication of subdivision into two segments, especially visible on the dorsal side. The abdomen is 3-segmented. The actual and proportional lengths of the rostrum, body segments, and caudal rami are:

Rostrum	Head plus somite of leg 1	2	3	4	5	6	1	2	3	Caudal rami
27μ	177	79	70	71	66	109	68	54	50	23
3	22	10	9	9	8	14	9	7	6	3 = 100

The greatest body width is at the level of the first leg-bearing thoracic segment where it is 206μ. The length of the inner long seta on the caudal ramus is 419μ.

The rostrum (Fig. 2), curved slightly ventrally, narrows to a rounded point distally, and bears two small setae dorsally. The head and first four leg-bearing thoracic segments bear minute setae (Fig. 3) whose number and arrangement are difficult to discover because of the opacity of the body in preserved specimens. The fifth leg-bearing thoracic, genital, and abdominal segments are armed as indicated in Figs. 1, 3, and 4. The dorsal subdivision of the genital segment is marked by a medially interrupted transverse row of small setae as well as by the cuticular furrow. The anal operculum has a row of dentiform setae along the free edge. On either side of the operculum there is a row of spines which continues around on the ventral surface, becoming progressively smaller.

The caudal ramus (Figs. 5 and 6), slightly wider than long, bears distally two long setae of unequal length. These setae show a distinct "joint" near their bases of slightly different appearance in dorsal and ventral views. Four shorter setae are also associated with the caudal ramus, two on the outer distal corner, one on the inner distal corner, and one with a jointed base on the distal dorsal surface of the ramus. In a single individual the two long setae on the left caudal ramus were retracted by a double folding near the bases, as shown in Fig. 7, while the setae on the corresponding right caudal ramus were in the usual extended position.

The egg sac (Figs. 3 and 8), flattened dorsoventrally and measuring about 262 x 157μ, by 85μ in thickness, reaches well beyond the caudal rami. It contains 28–30 eggs arranged in two layers, each egg about 51μ in diameter.

The first antenna (Fig. 9) has eight podomeres with the actual and proportional lengths as follows:

1	2	3	4	5	6	7	8
19μ	33	18	24	13	16	13	22
12	21	12	15	8	10	8	14 = 100

The entire antenna exclusive of setae is about 160μ long. On the fourth podomere there is an aesthetask or sensory filament 110μ in length, extending beyond the tip of the antenna. The first podomere bears a longitudinal row of small slender spines and a feathered seta at the inner distal corner. There is a small feathered seta about midway on the inner edge of the second podomere. The second antenna (Fig. 10) has a short basipodite, an endopodite of two podomeres,

FIGS. 1–16.—*Nitocra medusaea*, n. sp., female: 1, Body segments, dorsal view; 2, rostrum, dorsal view; 3, lateral view of body, thoracic and head appendages omitted; 4, genital segment and abdomen, ventral view; 5, caudal ramus, ventral view; 6, caudal ramus, dorsal view; 7, caudal ramus with retracted setae, ventral view; 8, egg sac; 9, first antenna; 10, second antenna; 11, mandible; 12, first maxilla; 13, second maxilla; 14, maxilliped; 15, first swimming leg, anterior view; 16, second swimming leg, anterior view. (All figures were drawn with the aid of a camera lucida. Scale A applies to Figs. 1, 3, 4, and 21; scale B to Figs. 2, 5, 6, 9, 15–18, 23, 25–27, and 42–46.)

Figs. 17–27.—*Nitocra medusaea*, n. sp., female: 17, Third swimming leg, anterior view; 18, fourth swimming leg, anterior view; 19, fifth leg; 20, sixth legs and opening of reproductive system on ventral surface of genital segment. Same, male: 21, fifth legs, genital segment, and abdomen, ventral view; 22, first antenna; 23, first swimming leg, anterior view; 24, spine on inner distal corner of basipodite of first swimming leg; 25, second swimming leg, anterior view; 26, third swimming leg, anterior view; 27, fourth swimming leg, anterior view. (Scale C applies to Figs. 7, 24, and 31; scale D to Figs. 10–14, 19, 20, 22, 28, 36, 37, 60, and 62.)

and an exopodite of a single podomere bearing three terminal setae.

The mandible (Fig. 11) has a swollen basipodite with a long slender masticatory lobe and a palp of two podomeres. The first and second maxillae are as illustrated in Figs. 12 and 13. The maxilliped (Fig. 14) consists of an elongated basipodite bearing a single feathered seta distally and a single endopodite podomere having a long prehensile claw at the distal end.

The first four pairs of swimming legs have rami of three podomeres. The first pair of legs (Fig. 15) is somewhat smaller than the succeeding pairs. The coxopodite is armed on the outer anterior surface by a group of spines, on the outer posterior surface by two groups of fine hair-like setae (present on all four swimming legs), on the mid-anterior surface by a transverse row of fine setae, and on the inner lobe by a row of small spines. The basipodite bears externally a finely denticulate spine, with a row of spines near its base, another row of spines along the distal edge of the basipodite between the bases of the two rami, and a large spine with smaller spines at its base on the inner distal corner. The middle podomere of the exopodite bears an inner seta. The first podomere of the endopodite bears an inner distal seta and is about as long as the first two exopodite podomeres together. The distal two endopodite podomeres combined are shorter than the first podomere, so that the entire endopodite is slightly shorter than the exopodite.

The coxopodite of the second pair of legs (Fig. 16) lacks the group of spines on the outer anterior surface and the transverse row of setae. The spines on the inner lobe are very slender and hair-like. There is no spine on the inner distal corner of the basipodite. The endopodite is distinctly shorter than the exopodite. The coxopodite of the third pair of legs (Fig. 17) is armed only with two groups of fine hair-like setae on the posterior outer surface. The outer corner of the basipodite bears a seta raised on a short pedicel, instead of a spine. The coxopodite and basipodite of the fourth pair of legs (Fig. 18) are armed like the third pair. The setal formula for the first our pairs of legs is:

	Leg 1		Leg 2		Leg 3		Leg 4	
	Exp.	End	Exp.	End	Exp.	End	Exp.	End
1st podomere.....	1:0	0:1	1:0	0:1	1:0	0:1	1:0	0:1
2d podomere......	1:1	0:1	1:1	0:1	1:1	0:1	1:1	0:1
3d podomere......	5	3	7	4	7	5	7	5

The proximal podomere of the fifth pair of legs (Fig. 19) has an outer pedicellate seta and an inner swollen lobe bearing five setae, the three inner ones being shorter and of about equal length. Adjacent to the outermost seta on the lobe there is a row of 2–4 short spines. Along the almost straight inner edge of the lobe there are several small spines. The inner lobes of the two fifth legs are not united medially. The distal podomere is slightly longer than wide, with the outer edge nearly straight and the inner edge expanded. Distally there are five setae, the next to the innermost one being over twice as long as any of the others. Along the outer edge there are two groups of small spines, and on the inner edge there is a row of 5–6 slender spines. The sixth pair of legs is represented by a single small seta at either side of the opening of the oviduct (Fig. 20), visible on the anterior ventral part of the genital segment.

Male.—In general appearance the male resembles the female, but the body is distinctly smaller. The total length, based on five specimens, is 0.62 mm (0.60–0.64 mm). The ratio of length of the head (plus rostrum) and the first five leg-bearing thoracic segments to the genital segment and abdomen (plus caudal rami) is 37:25. The abdomen is 4-segmented. The actual and proportional lengths of the rostrum, body segments, and caudal rami are:

Rostrum	Head plus somite of leg 1	2	3	4	5	6	1	2	3	4	Caudal rami
22μ	140	57	50	52	49	53	52	48	43	38	18
3	23	9	8	8	8	9	8	8	7	6	3 = 100

The greatest body width is 157μ at the level of the first leg-bearing thoracic segment. The length of the inner long seta on the caudal ramus is 337μ.

The head and first four leg-bearing thoracic segments have a setal ornamentation much like that in the female. On the fifth leg-bearing thoracic and genital segments (Fig. 21) a row of small setae passes around the posterior dorsal area from the base of one leg to the corresponding leg on the opposite side, leaving the area between the bases of the legs free of setae. Both first and second abdominal segments have a transverse row of setae encircling the posterior region of the somite. The third segment has a similar transverse row and in addition a short row on each side of the somite. The last abdominal

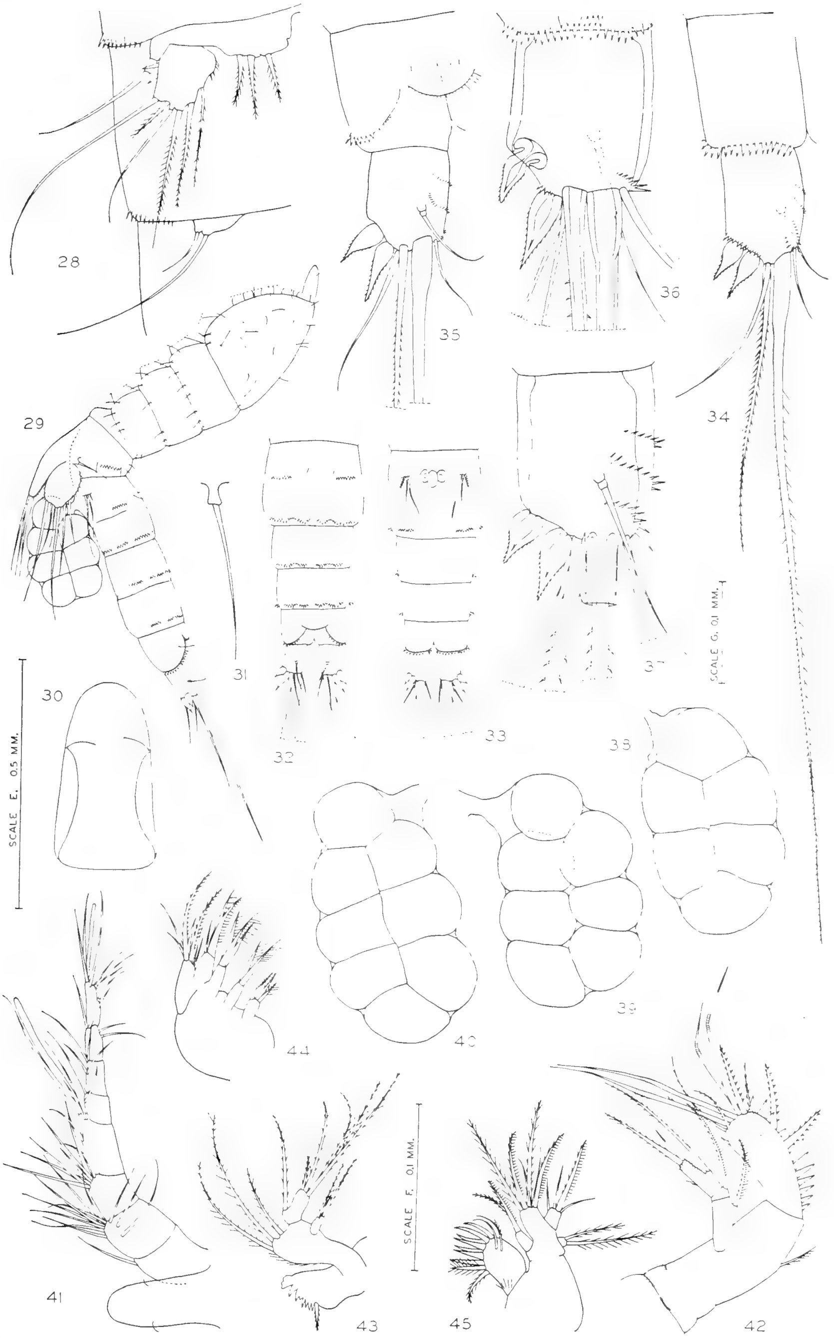


Fig. 28.—*Nitocra medusaea*, n. sp., male: fifth and sixth leg.

Figs. 29–45.—*Mesamphiascus ampullifer*, n. sp., female: 29, lateral view; 30, rostrum, dorsal view; 31, a seta from the posterior border of a thoracic segment; 32, genital segment and abdomen, dorsal view; 33, genital segment and abdomen, ventral view; 34, part of last abdominal segment and caudal ramus, ventral view; 35, part of last abdominal segment and caudal ramus, dorsal view; 36, caudal ramus, showing partly retracted flask-shaped seta, ventral view; 37, caudal ramus, showing partly retracted long terminal seta, dorsal view; 38, egg sac with 6 eggs, lateral view; 39, egg sac with 7 eggs; 40, egg sac with 8 eggs; 41, first antenna and rostrum; 42, second antenna; 43, mandible; 44, first maxilla; 45, second maxilla. (Scale E applies to Figs. 29, 32, 33, and 54–56; scale F to Figs. 34, 35, 41, 47–53, 57–59, 61, and 63; scale G to Figs. 38–40.)

segment has two lateral rows and a transverse ventral row. The armature of the anal operculum and caudal rami is like that of the female.

The first antenna (Fig. 22) has eight podomeres of the following actual and proportional lengths (measuring along the outer margins):

1	2	3	4	5	6	7	8
22μ	25	7	28	21	21	11	10
15	18	4	19	15	14	8	7 = 100

The first and second podomeres both bear a single feathered seta as in the female. The inner margins of podomeres three, four, and five are thickened and irregular, the last two with processes bearing a row of small spines. From the distal edge of the fourth podomere arises an aesthetask 118 x 6μ, extending far beyond the end of the antenna. When the antenna is bent in the usual geniculate position, the aesthetask is equal in length to the antenna from its base to the outer angle of flexure.

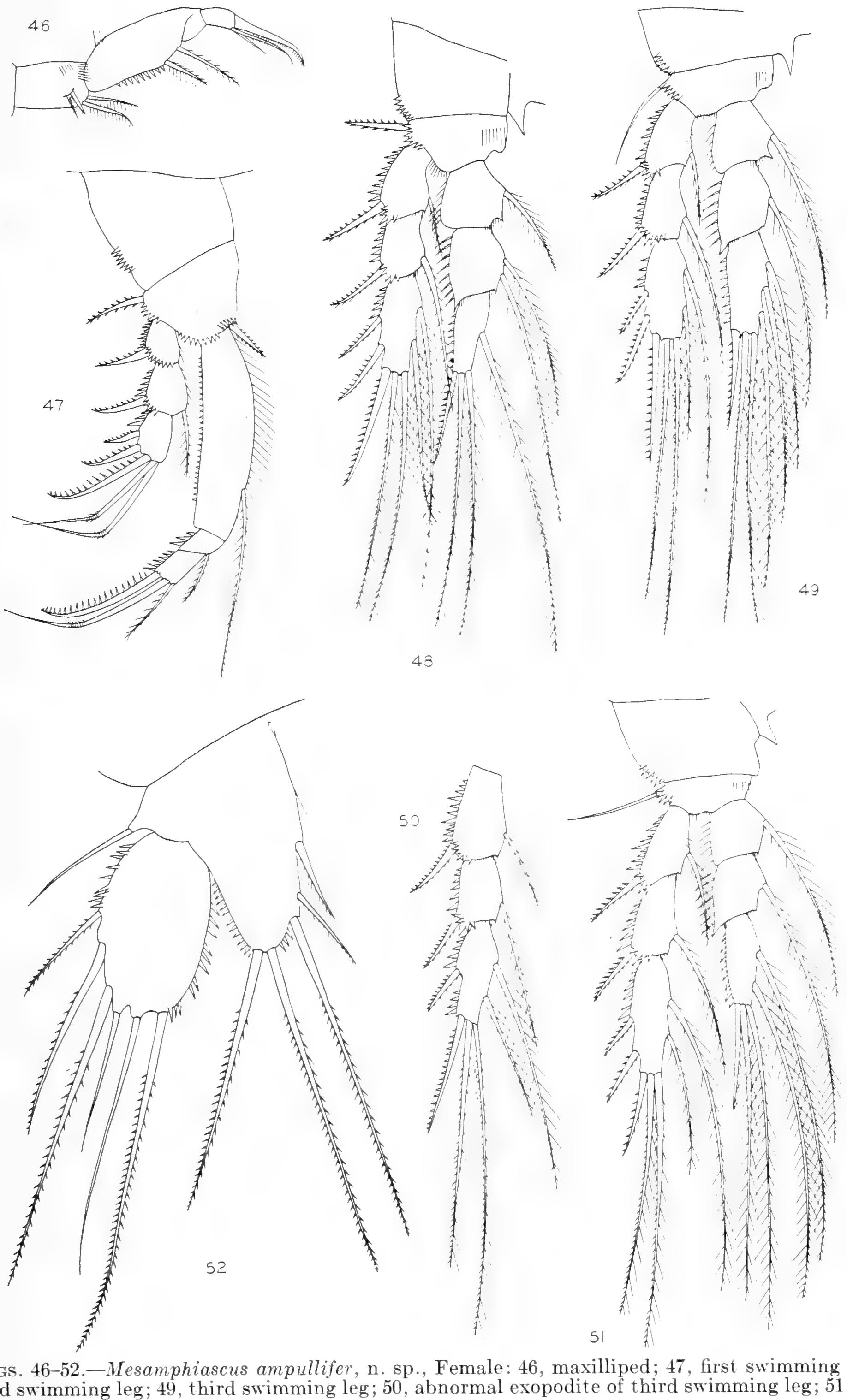
The second antenna, mandible, first maxilla, second maxilla, and maxilliped are like those of the female.

The first pair of swimming legs (Fig. 23) is armed in most respects like that of the female, except for the coxopodite lacking the transverse row of small setae on the anterior surface and the basipodite having the inner spine modified. The form of the spine (Fig. 24) might be described as subchelate. There is no indication, however, that the finger is movable. A row of small spines occurs near the base of this modified spine. The second pair of legs (Fig. 25) is in all important features of armature like that of the female. The third pair of legs (Fig. 26) is also similar to that of the female, except that the middle seta on the end of the last endopodite podomere is less than half as long as in the female. The fourth pair of legs (Fig. 27) resembles closely that of the female, even to the extent of having the next to the innermost seta on the last podomere of the exopodite characteristically spined, whereas in the second and third legs it is coarsely feathered. The setal formula for the four pairs of swimming legs is identical with that given for the female.

The proximal podomere of the fifth pair of legs (Fig. 28) bears an outer pedicellate seta and an expanded inner lobe bearing three feathered setae in a row. The inner lobes of the two fifth legs are not united medially. The distal podomere is slightly longer than wide, of a somewhat irregular shape, bearing six setae along the distal edge as indicated in the figure. A group of small spines occurs on the inner edge and two larger spines on the outer edge. The sixth pair of legs (Fig. 28) is represented by a low expansion bearing two unequal setae at the outer distal corner.

Remarks.—According to Lang (1948) there are eighteen certain species in the genus *Nitocra*. *Nitocra medusaea*, with the first endopodite podomere of the first leg of the female shorter than the exopodite, differs from *N. typica* Boeck, *N. pontica* (Jakubisiak), *N. pusilla* Sars, *N. mediterranea* (Brian), *N. hibernica* (Brady), *N. affinis* Gurney, *N. elegans* (T. Scott), and *N. minor* Willey, which have that podomere at least as long as the exopodite. Having the terminal podomere of the endopodite of the first leg of the female about as long as the middle podomere, it differs from *N. bdellurae* (Liddell), in which the terminal podomere is twice as long as the middle one. In having six setae on the distal podomere of the fifth leg in the female, it is unlike *N. fallaciosa* Klie and *N. fragilis* Sars, which have five. With the first podomere of the endopodite of the first leg of the female about as long as the first two exopodite podomeres, it differs from *N. lacustris* (Schmankevitsch), *N. spinipes* Boeck, *N. dubia* Sars, and *N. platypus* Daday, in which it is distinctly shorter than the two exopodite podomeres. In having three setae on the inner expansion of the proximal podomere of the fifth leg in the male, it differs from *N. malaica* Kiefer and *N. sewelli* Gurney, which have only two. With the caudal rami slightly wider than long, it is unlike *N. divaricata* Chappuis where they are 1.5–2 times longer than wide. Other differences are also to be found, but the single characters selected above serve to distinguish each already known species from *N. medusaea*.

Nitocra chelifer Wilson (1932) is thought by Lang (1948) to represent a mixture of at least two species, the male being a *Nitocra* perhaps identical with *hibernica*, and the female being probably a *Proameira*. The taxonomic uncertainty is difficult to clarify because of the existence of only two known specimens, a holotype male and a paratype female, both undissected, in the U. S. National Museum. The female, however, differs from *N. medusaea* in having the terminal podomere of the endopodite of the first leg narrow and more than twice as long as the middle podomere. The male differs from the new



FIGS. 46–52.—*Mesamphiascus ampullifer*, n. sp., Female: 46, maxilliped; 47, first swimming leg; 48, second swimming leg; 49, third swimming leg; 50, abnormal exopodite of third swimming leg; 51, fourth swimming leg; 52, fifth leg.

species in having the first podomere of the endopodite of the first leg much longer than the first two exopodite podomeres and in having five setae on the inner expansion of the proximal podomere of the fifth leg.

Members of the genus *Nitocra* occur in fresh, brackish, or salt water. Two species are known to be semiparasitic. *N. bdellurae* lives in the egg capsules of *Bdelloura propinqua* Wheeler and *B. candida* (Girard), flatworms which live upon the carapace of the horseshoe crab, *Limulus*. There it feeds on the embryos of the worms, according to Liddell (1912). *N. divaricata* lives in the gill chambers of crayfishes, *Astacus fluviatilis* according to Chappuis (1926) and *A. leptodactylus* according to Jakubisiak (1939). *Nitocra medusaea* is thus the third species in the genus known to have definite semiparasitic relationships.

Mesamphiascus ampullifer, n. sp.

Several hundred specimens of this copepod were recovered from the mouthparts of eight small adult American lobsters, *Homarus americanus* Milne-Edwards, purchased alive on July 30, 1952, from a lobster market at Portsmouth, N. H. Except for the statement of the proprietor that all the lobsters had been caught locally in the vicinity of Portsmouth, their origin is uncertain. The copepods, including nauplii, copepodids, and adults, were found clinging to the many hairlike setae on the flattened inner edges of the proximal endite lobes (presumably belonging to the coxopodites) of the first maxillipeds. They occurred nowhere else unless disturbed by probing with a needle or intense light. Then they crawled actively over the other mouthparts, reminding one very much of lice as they crawled among the setae of these appendages. When removed to a watch glass of sea water, they swam vigorously at first, but soon came to rest on the bottom of the dish, from which they would then only sporadically arise to swim freely. Their behavior toward light seemed to be slightly negative.

The type material consists of a holotype female (No. 95308), an allotype (No. 95309), and paratypes (150 females and 100 males, No. 95310), all deposited in the United States National Museum. Other paratypes are in the author's collection.

Female.—The body (Fig. 29), excluding the intestinal contents, is colorless except for a bright red eye. The intestine of specimens freshly removed from the host is pale yellow and may contain reddish or orange droplets, conferring a tinge of color to the animal. The total length (measuring from the tip of the rostrum to the posterior end of the caudal rami), based on five specimens, is 1.041 mm (0.975–1.081 mm). The ratio of length of the head (plus rostrum) and the first five leg-bearing thoracic segments to the genital segment and abdomen (plus caudal rami) is 60:44. The genital segment shows a slight indication of subdivision into two segments, marked by weak lateral furrows and a row of setae. The abdomen is 3-segmented. The actual and proportional lengths of the rostrum, body segments, and caudal rami are:

Rostrum	Head plus somite of leg 1	2	3	4	5	6	1	2	3	Caudal rami
73μ	268	78	79	66	34	130	97	85	65	65
7	26	8	8	6	3	13	9	8	6	6 = 100

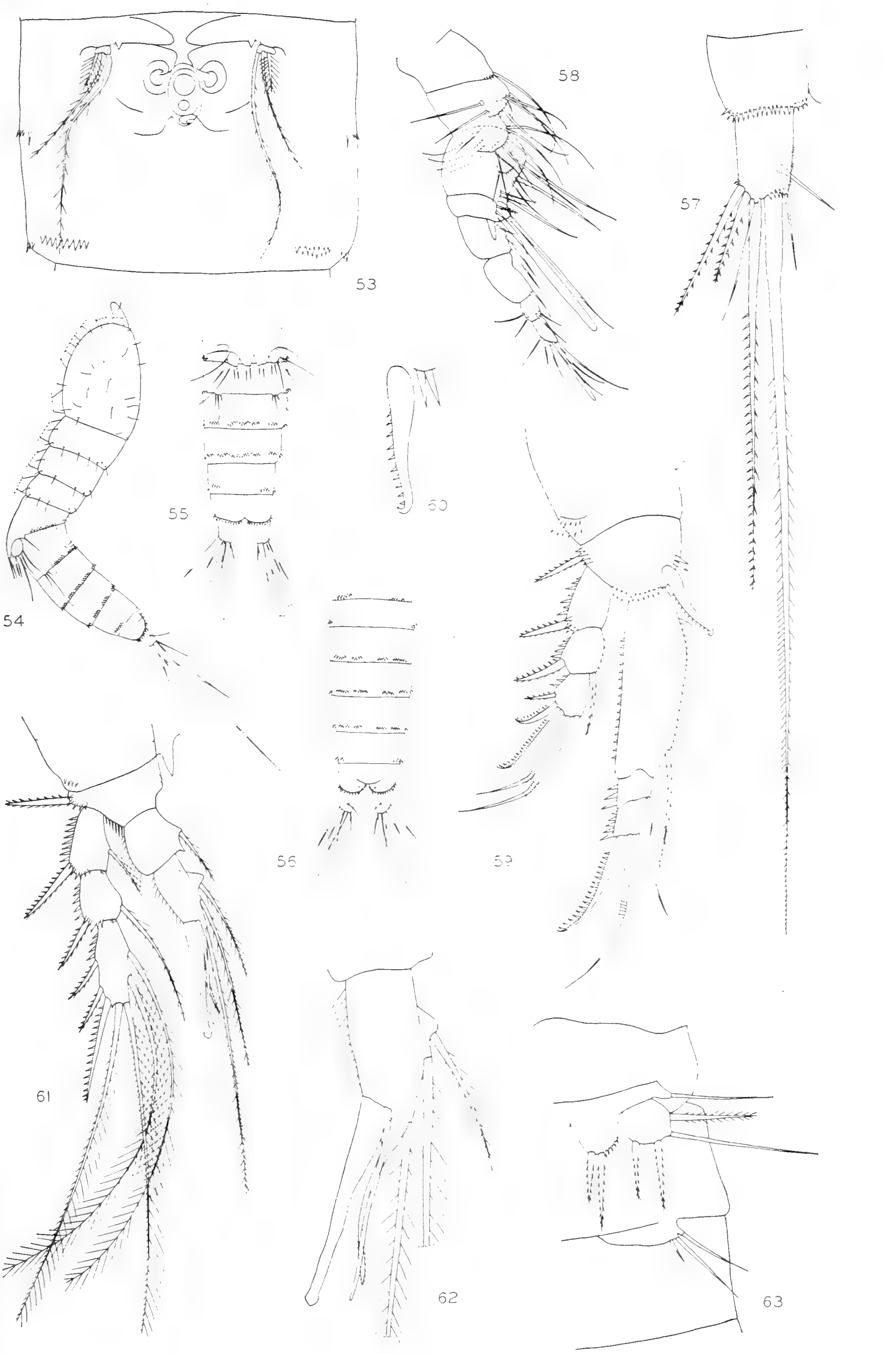
The greatest body width is 188μ at the level of the first leg-bearing thoracic segment. Length of longest seta on caudal ramus is 430μ.

The rostrum (Fig. 30) curves slightly downward, tapering to a blunt, rounded end and bearing two small setae on the dorsal surface. The head and first four leg-bearing thoracic segments bear minute setae (many only 10μ long) as shown in Fig. 29. Many of the setae on the posterior borders of these segments arise from slender pedicels (Fig. 31). The fifth leg-bearing thoracic, genital, and abdominal segments are armed with setae as indicated in Figs. 29, 32, and 33. The anal operculum bears a row of fine setae distally.

The caudal ramus (Figs. 34 and 35), about twice as long as wide, bears two flask-shaped setae at the outer distal corner. The base of the longest terminal seta is slightly swollen. On the dorsal surface of the ramus there is a small seta with a 2-jointed pedicel. Three oblique rows of small spines pass around the inner margin of the ramus. Both the flask-shaped setae and the longest terminal seta may be partially retracted as in Figs. 36 and 37 respectively. The remaining setae of the ramus are indicated in the figures.

The two egg sacs (Fig. 38), each about 47 x 32μ, are laterally flattened and extend only to a little beyond the middle of the first abdominal segment. Each sac usually contains six eggs, each egg about 50μ in diameter. Occasionally there are seven eggs (Fig. 39) or eight eggs (Fig. 40).

The first antenna (Fig. 41) has eight podomeres



FIGS. 53–63.—*Mesamphiascus ampullifer*, n. sp., female: 53, Genital segment, ventral view, showing reproductive opening and sixth legs. Same, male: 54, lateral view, head and thoracic appendages omitted; 55, fifth legs, genital segment, and abdomen, ventral view; 56, genital segment and abdomen, dorsal view; 57, part of last abdominal segment and caudal ramus, ventral view; 58, first antenna; 59, first swimming leg; 60, inner basipodite spine and associated spines on first leg; 61, second swimming leg; 62, distal endopodite podomere of second leg; 63, fifth and sixth legs.

with the actual and proportional lengths as follows:

1	2	3	4	5	6	7	8
32μ	27	28	28	17	18	20	27
16	14	14	14	9	9	10	14 = 100

The entire antenna is 197μ long. On the fourth podomere there is an aesthetask 73μ long, reaching to about the tip of the antenna. On the distal podomere there is a second aesthetask, slenderer than the previous one, and about 38μ long. There are no feathered setae. The second antenna (Fig. 42) bears an exopodite of three podomeres, the middle one of which has a single seta.

The mandible (Fig. 43) has a small exopodite and endopodite, both of a single podomere. The first and second maxillae are as shown in Figs. 44 and 45. The maxilliped (Fig. 46) bears a pectinate claw distally.

The first four pairs of legs have rami of three podomeres. In the first pair (Fig. 47) the exopodite is only one-half as long as the endopodite. The coxopodite bears a row of spines on the outer distal area. The basipodite bears an inner and an outer seta, with smaller spines as indicated in the figure. The middle podomere of the exopodite bears a single seta. The first podomere of the endopodite is much longer than the entire exopodite, while the two distal segments are short, the proportions of the three being about 77:9:14. The basipodite of the second pair of legs (Fig. 48) lacks the inner spine, there being a row of slender setae near that point. The third pair of legs (Fig. 49) is in most respects similar to the second, except for an increase in the number of setae on the endopodite as indicated in the table below. In a single specimen an abnormal exopodite (Fig. 50) with only six setae instead of seven on the terminal podomere was noted, the exopodite of the opposite side being normal. The fourth leg (Fig. 51) closely resembles the third except for one less seta on the terminal endopodite podomere.

The setal formula for the first four pairs of legs is:

	Leg 1		Leg 2		Leg 3		Leg 4	
	Exp.	End	Exp.	End	Exp.	End	Exp.	End
1st podomere	1:0	0:1	1:1	0:1	1:1	0:1	1:1	0:1
2d podomere	1:1	0:1	1:1	0:2	1:1	0:1	1:1	0:1
3d podomere	5	3	7	4	7	6	7	5

The proximal podomere of the fifth pair of legs (Fig. 52) has an outer pedicellate seta and an elongated lobe bearing five setae plus a row of small spines along its distal edge. The two lobes of the right and left sides are not fused medially. The distal podomere is in the shape of an elongated oval, with the length to width as 15:9. There are six setae along the distal edge, the two nearest the innermost seta being slender and without lateral spines. Of these two slender setae the outer one is characteristically only a little more than one-half as long as the inner one. Both inner and outer edges of this podomere proximal to the large distal spines are armed with groups of small spines. A sixth pair of legs (Fig. 53), each leg consisting of a minute base bearing three setae, is present on either side of the genital opening. Of these three setae the innermost is the longest and the outermost is relatively short with long lateral hairs.

Male.—In general appearance the male resembles the female, except for the smaller body size and the modified first antennae. The total length, based on five specimens, is 0.88 mm (0.87–0.89 mm). The ratio of the head (plus rostrum) and the first five leg-bearing thoracic segments to the genital segment and abdomen (plus caudal rami) is 52:36. The abdomen (Fig. 54) is 4-segmented. The actual and proportional lengths of the rostrum, body segments, and caudal rami are:

Rostrum	Head plus somite of leg 1	2	3	4	5	6	1	2	3	4	Caudal rami
62μ	238	67	64	56	30	54	66	68	66	57	49
7	27	8	7	6	3	6	8	8	8	7	6 = 100

The greatest body width is 157μ at the level of the first leg-bearing thoracic segment. The length of the inner long seta on the caudal ramus is 415μ.

The head and first four leg-bearing thoracic segments bear small setae as indicated in Fig. 54. These setae are arranged in general like those of the female. The fifth leg-bearing thoracic, genital, and abdominal segments are armed as shown in Figs. 54, 55, and 56. The arrangement of the seven major setae on the caudal ramus (Fig. 57) is like that of the female. Instead of the two flask-shaped setae on the outer distal corner, however, there are two tapering setae with minute lateral spines.

The first antenna (Fig. 58) has eight podomeres of the following actual and proportional lengths (measuring along the outer margins):

1	2	3	4	5	6	7	8
29μ	34	39	13	29	30	13	19
14	17	19	6	14	15	6	9 = 100

On the inner edge of the fourth podomere there is a minute feathered seta. From this region there arises also an aesthetask about 77μ long. A second aesthetask much slenderer and about one-half as long is borne on the end of the distal podomere. Podomeres 3–6 have irregular chitinized processes along their inner surfaces. The third podomere is noticeably swollen. The second antenna, mandible, first maxilla, second maxilla, and maxilliped are like those of the female.

The first swimming leg (Fig. 59) has proportions and armature much like the female. The inner basipodite spine, however, is hooked at its tips and bears a row of minute spines along the edge (Fig. 60). Near its base there are two smaller spines. The second swimming leg (Fig. 61) differs from the first, third, and fourth in that the endopodite has apparently two podomeres, the second and third podomeres having become fused. The six setae on the distal endopodite podomere (Fig. 62) may be homologized with the setae of the second and third podomeres of the female endopodite. The two setae on the middle inner edge correspond to the two belonging to the second podomere in the female. The long feathered seta distal to these two corresponds to the seta arising from the middle inner edge of the third podomere of the female. The three greatly modified terminal setae correspond to the three terminal setae of the female. The third and fourth swimming legs are like those of the female.

The setal formula for the first four pairs of legs is:

	Leg 1		Leg 2		Leg 3		Leg 4	
	Exp.	End	Exp.	End	Exp.	End	Exp.	End
1st podomere	1:0	0:1	1:1	0:1	1:1	0:1	1:1	0:1
2d podomere	1:1	0:1	1:1	6	1:1	0:1	1:1	0:1
3d podomere	5	3	7		7	6	7	5

The proximal podomere of the fifth leg (Fig. 63) bears an outer pedicellate seta and an inner lobe with two setae and a row of small spines. The distal podomere is slightly wider than long, the two dimensions being in the proportion of 11:9. It bears four setae, the seta next to the outermost being longest and without lateral hairs. The sixth leg (Fig. 63) consists of three setae arising from a low ridge along the posterior margin of the genital segment.

Remarks.—Although *M. ampullifer* has certain very distinctive features, such as the sexual dimorphism of the two outer setae on the caudal rami, its generic position may be subject to at least two interpretations of the species in the Diosaccidae. Lang (1948) described sixteen new genera in the family, bringing the total to twenty-seven. *M. ampullifer* possesses characteristics which seem to be of taxonomic importance equal to those used to separate genera within the family. It does not seem possible, therefore, to place this new species in any of the genera recognized by Lang.

It is possible, however, to place the new species in the genus *Mesamphiascus* Nicholls. In his revision of the Diosaccidae Nicholls (1941) erected the subfamily Amphiascinae, basing his concept upon the setation of the middle podomeres of the second and third endopodites. In this subfamily he placed *Robertsonia* Brady, *Schizopera* Sars, *Amphiascopsis* Gurney, *Amphiascus sens. str.*, and the new genera *Amphiascoides* and *Mesamphiascus*. The last named genus he described as having two inner setae on the middle podomere of the second endopodite and one inner seta on the middle podomere of the third endopodite. *Mesamphiascus* as thus defined by him included twenty-six species, the type selected being *Amphiascus parvus* Sars. Until more is known about the species of the Diosaccidae and their true generic relationships can be interpreted, it seems better to place this new species from the lobster in *Mesamphiascus* Nicholls than to erect a new genus for it.

M. ampullifer may be distinguished from the recognized species of *Mesamphiascus* by the flask-shaped setae on the caudal rami of the female. Only one other species in the genus *M. bulbifer* (Sars) has setae on the caudal rami modified in a similar manner. In this species, however, it is the outer of the two long setae which is modified, not the two setae at the outer distal corner as in *M. ampullifer*. Whether or not this modification is sexually dimorphic as in *M. ampullifer* is not known, since only females of *M. bulbifer* have been described. Sexual dimorphism, however, is known in a few other harpacticoid genera, such as *Attheyella* and *Huntemannia*. Basal swelling or expansion of the setae on the caudal rami has been described in many harpacticoids, as discussed by Sewell (1940), but usually the two long setae are the ones affected and often it is not clear whether the condition is sexually dimorphic. Swollen setae on the outer distal corner of the caudal ramus are not entirely unknown in other harpacticoids, one having been described by Klie (1929) in the female of his *Paramesochra holsatica*.

M. ampullifer differs further from all other species in the genus in the character of the inner basipodite seta of the first leg of the male and in the armature of the endopodite of the second leg of the male. It seems also to be unlike most other known species in having a small aesthetask on the terminal podomere of the first antenna. This feature, however, may be common to other species. Such an aesthetask is apparently figured by Sewell (1940) in his new species *Amphiascus calcarifer*, f. *major*, though not mentioned in the text. The aesthetask is so small that in the group of terminal setae it might easily be overlooked.

The majority of the members of the Diosaccidae for which ecological information is available are free-living, in salt, brackish, or fresh water. Numerous species of marine harpacticoids have been found by Jakubisiak (1932 and 1936) among the algae and animal colonies attached to the carapace of the crab, *Maia squinado* (Herbst), among them *Diosaccus tenuicornis* (Claus), *Amphiascopsis phyllopus* (Sars), *Mesamphiascus parvus* (Sars), *Amphiascoides debilis* (Giesbrecht), and *Amphiascoides hispidus* (Norman MS, Sars). These five species of Diosaccidae also occur, however, in sand and among algae, being found normally in the latter habitat, according to Monard (1935). They probably live not as true commensals or as semiparasites but as free animals in the ecological niche provided by the thick growth on the crab carapace. Another species, *Amphiascoides commensalis* (Seiwell), lives as a commensal in the branchial chamber of the ascidian, *Amaroucium*, according to Seiwell (1928). *M. ampullifer* thus appears to be the second species in the Diosaccidae known to have definite relationships with a host animal, although its morphological modifications for clinging to the host are not highly developed.

The only other harpacticoid known from the lobster is *Unicalteutha ovalis* Wilson, 1944 (Peltidiidae). This copepod occurs commonly on lobsters in Newfoundland (Templeman and Tibbo, 1945), where it is found chiefly in restricted areas on the chelipeds.

After the above description had been completed, twelve preserved lobsters, comprising nine females and three males, were found parasitized by *M. ampullifer*. These lobsters had been used for class study for five years and their collection locality is unknown. Three of the females and two of the males had many nauplii and copepodids as well as adults. All stages of the copepods were confined to the setose flattened edges of the proximal endite lobes of the first maxillipeds.

Nine live lobsters, including four males and five females, collection locality unknown, purchased from a Boston fish market in March, 1953, were also parasitized by these copepods. Over 100 copepods, including nauplii, copepodids, and adults, were removed from each. From one female 370 adult copepods were recovered. When it is considered that the combined area of the flattened edges of the two endite lobes where they were clinging was not more than about 28 square millimeters, the heavy degree of infestation may be appreciated.

M. ampullifer seemed to be particularly hardy when removed from the host, since some individuals survived for 41 days at about 70 degrees F. in a watch glass of sea water changed weekly but without special aeration.

M. ampullifer thus appears to be a common parasite of lobsters in the New England area, since it has been found on all 29 thus far examined. This, together with the fact that it occurs in such large numbers and on such a restricted part of the host's body, would tend to support the conclusion that it normally lives upon the lobster.

LITERATURE CITED

Chappuis, P. A. *Harpacticiden aus der Kiemenhöhle des Flusskrebses.* Arch. Hydrobiol. **17:** 515–520. 1926.

Jakubisiak, S. *Sur les harpacticoïdes hébergés par* Maia squinado. Bull. Soc. Zool. France **57:** 506–513. 1932.

———. *Matériaux à la faune des harpacticoïdes de Roscoff (côtes bretonnes, France).* Fragm. Faun. Mus. Zool. Polon. **2:** 315–321. 1936.

———. *Sur le copépode* Nitocrella divaricata *(Chappuis) commensal de l'écrevisse.* Arch. Hydrobiol. i Rybactwa **12:** 117–121. 1939.

Klie, W. *Die Copepoda Harpacticoida der südlichen* *und westlichen Ostsee mit besonderer Berücksichtigung der Sandfauna der Kieler Bucht.* Zool. Jahrb., Abt. Syst. **57:** 329–386. 1929.

Lang, K. *Monographie der Harpacticiden*, 2 vols. Lund, Sweden. 1948.

Liddell, J. A. Nitocrameira bdellurae, *nov. gen. et sp., a copepod of the family Canthocamptidae, parasitic in the egg cases of* Bdellura. Journ. Linn. Soc. London, Zool., **32:** 87–94. 1912.

Monard, A. *Étude sur la faune des harpacticoïdes marins de Roscoff.* Trav. Stat. Biol. Roscoff, fasc. 13: 5–88. 1935.

Nicholls, A. G. *A revision of the families Diosaccidae Sars, 1906 and Laophontidae T. Scott, 1905 (Copepoda, Harpacticoida).* Rec. South Australian Mus. **7:** 65–110. 1941.

Sars, G. O. *An account of the Crustacea of Norway with short descriptions and figures of all the species.* **5** and suppl. Bergen, Norway, 1911.

Seiwell, H. R. *Two new species of commensal copepods from the Woods Hole region.* Proc. U. S. Nat. Mus. **73** (art. 18): 1–5. 1928.

Sewell, R. B. S. *Copepoda, Harpacticoida.* The John Murray Expedition 1933–34 Scientific Reports **7:** 117–382. 1940.

Templeman, W., and Tibbo, S. N. *Lobster investigations in Newfoundland 1938 to 1941.* Newfoundland Govt. Dept. Natural Resources, Res. Bull. **16** (Fisheries): 1–98. 1945.

Wilson, C. B. *The copepods of the Woods Hole region Massachusetts.* U. S. Nat. Mus. Bull. **58:** 1–635. 1932.

———. *Parasitic copepods in the United States National Museum.* Proc. U. S. Nat. Mus. **94:** 529–582. 1944.

ZOOLOGY.—*A burrowing barnacle of the genus* Trypetesa (order Acrothoracica).[1]

Jack T. Tomlinson, Department of Zoology, University of California. (Communicated by Fenner A. Chace, Jr.)

A previously unreported acrothoracican barnacle has been found burrowing in *Tegula* shells occupied by hermit crabs in the intertidal zone of central California. A description and certain aspects of the life history of this form are given. A more detailed morphological study is in preparation for future publication.

Subclass Cirripedia (Lam.) Burmeister, 1834

Order Acrothoracica Gruvel, 1905

Diagnosis.—Boring cirripeds with soft mantle without calcareous plates; cirri reduced, concentrated toward posterior end of body, one pair in vicinity of mouth ("mouth cirri"), and widely separated from other pairs, remaining pairs 2, 3, or 4 in number. Three pairs of mouth appendages. Abdomen lacking (?). Hermaphroditic or sexes separate. Males dwarf. Ovaries in a more or less flattened part of mantle ("disk"), which serves at same time to anchor it in the hole. Development always includes a cypris stage, with a nauplius stage in most of the species studied. Live buried in chiton and barnacle plates, gastropod shells, and corals.

Suborder Apygophora Berndt, 1907

Diagnosis.—Sexes separate. Female: An external chitinous mantle "sack" more or less regularly rounded or oval serving to fix the animal in a burrow in a shell; one pair of biramous mouth cirri; three pairs of quadriarticulated and uniramous thoracic cirri, the first two pairs possessing small prickly pads on second articulation; two lateral folds on inside of mantle which are perhaps ovigerous frenae; alimentary canal a sacculated system without an anus; esophagus spineless; nervous system consists of brain and one ventral ganglion.

Rudimentary (dwarf) males: Small, fixed on upper part of disk of female or grouped on cavity in shell; in the form of an elongated bag, naked and transparent; with a small opening for passage of a well-developedprobosciform penis; only eyes, testis, seminal vesicle, and penis are developed.

Cyprid larvae with six pairs of thoracic appendages biramous and natatory; abdominal segment with two large appendages.

Family Trypetesidae Kruger 1940 (=Alcippidae Gerstäcker, 1866; Gruvel, 1905).

With the characteristics of the suborder

Genus **Trypetesa** A. M. Norman, 1903

(=*Alcippe* Hancock, 1849; Darwin, 1854; Berndt, 1903, 1907; Genthe, 1905; Kuhnert, 1935; *Alcippoides* E. Strand, 1928. *Non Alcippe* Blyth, 1844.)

Trypetesa lampas (Hancock)

"Capitulum" laterally compressed, perpendicular to surface of the shell, with "disk" or ovigerous portion dorsoventrally compressed and

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[1] This work was completed in partial satisfaction of the requirements for the degree of master of arts in zoology at the University of California, under the supervision of Dr. Willard D. Hartman, to whom I am indebted for encouragement and assistance.

parallel to surface of host shell; nauplius free-swimming; adult exceeding 8 mm; bilaterally symmetrical; male attached only to disk of female; reported from the sublittoral of the northern Atlantic Ocean and the Mediterranean Sea.

Trypetesa lateralis, n. sp.

Laterally compressed throughout; no free-swimming nauplius; adult does not exceed 5 mm; not bilaterally symmetrical in mantle structure (lips of mantle opening asymmetrical; with a large external flap on left side of mantle only); male attached to disk of female or to the cavity wall near the external flap; found in littoral zone of central California.

Diagnosis.—Female laterally compressed throughout and situated laterally to right of slit in host shell, relative to point of attachment; "horny knob" of disk relatively small, on a recognizable stalk or peduncle; size not in excess of 5 millimeters; flap on the left surface of the mantle extends in adult to external surface of host shell, which it minutely perforates; retains young to cyprid stage; body proper resembles that of *Trypetesa lampas*, but much smaller; mantle sac not bilaterally symmetrical (Fig. 1); males may be numerous and attached to horny disk or knob of female or grouped on wall of cavity near external mantle flap.

The species is named for the wholly laterally compressed body and the orientation of the animal within the shell, laterally from the aperture.

Type specimen.—U. S. National Museum no. 93450.

Type locality.—Moss Beach, San Mateo County, Calif.

Dimensions of type.—Maximum diameter, 3.2 mm; right lip length 1.1 mm; dimension "A" (see Fig. 7), 1.85 mm; dimension "B", 2.7 mm.

Repositories of other type material.—California Academy of Sciences, San Francisco, Calif., no. 9857; Allan Hancock Foundation, University of Southern California, Los Angeles, Calif.; University of California Museum of Paleontology, Berkeley, Calif., no. 32960.

Distribution.—Point Arena, Mendocino County, Calif., to Shell Beach, San Luis Obispo County, Calif. (search for it was made at intervals from San Juan Island, Wash. to Ensenada, Baja California, Mexico. See Fig. 5). Intertidal. In *Tegula* shells occupied by all species of *Pagurus* within the range (all were in shells of *Tegula brunnea* and *T. funebralis* except for 3 *Calliostoma costatum* and 1 *Acanthina spirata*. Hermit crabs: *Pagurus granosimanus*, *P. hemphillii*; *P. hirsutiusculus*, and *P. samuelis*). A significant preference in the total sample for *T. brunnea* shells and for those occupied by *P. samuelis*. (This latter preferred association may result from the fact that *P. samuelis* is more abundant at the higher levels of the intertidal region where the barnacle itself is more abundant.

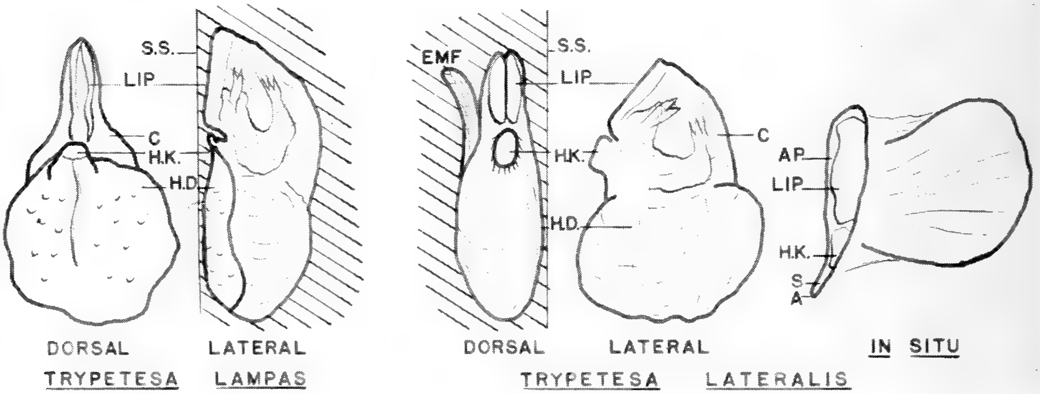

FIG. 1.—*Trypetesa lampas* (after Genthe) and *T. lateralis*.

ABBREVIATIONS USED IN FIG. 1

a—point of attachment.
ap—aperture of shell cavity.
c—capitulum.
e.m.f.—external mantle flap.
h.d.—horny disk.
h.k.—horny knob.
lip—lip or edge of mantle.
s.s.—shell surface (approx. relative position).
s.—slit (early aperture)

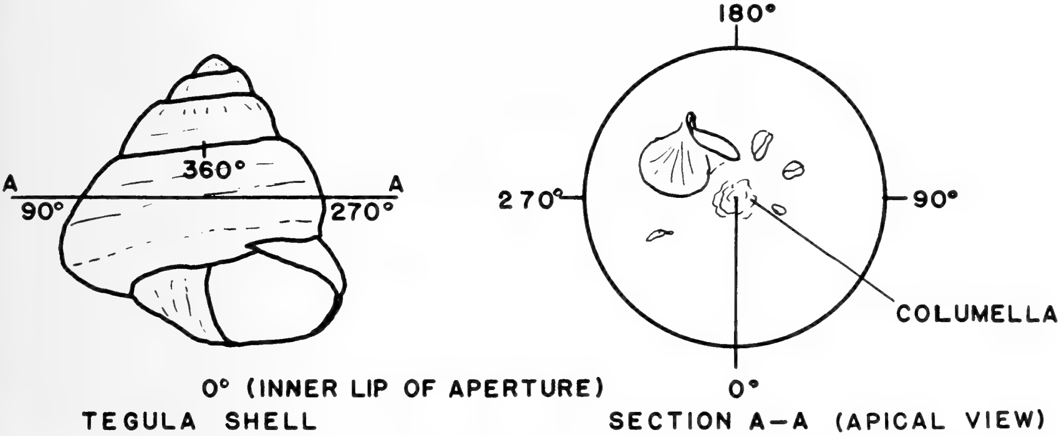

Fig. 2.—Plan of the body whorl of a *Tegula* shell to show the location of burrows of *Trypetesa lateralis*. Barnacles of different ages are shown.

At Haven's Neck, Mendocino County, *P. hemphillii* replaces *P. samuelis* in the higher zones, yielding evidence that the vertical zonation of the barnacle is dependent upon intertidal position rather than upon the species of hermit crab.) Specimens found in shells measuring from 7 to 16 mm in length of aperture; no correlation between size of shell and incidence of barnacles within the size range (over 1,000 shells examined).

Distribution within the shell: Of 1,315 barnacles 98.5 per cent were found in the body whorl with a slightly higher concentration at about 255° from the edge of the aperture (Fig. 2). They burrow on the posterior surface inside the shell (in the "floor" of the shell as viewed with the apex upward). The larvae apparently attach at random, but burrow with the point of attachment away from the columella. They may burrow entirely within the columella.

The flattened mantle is oriented parallel to the surface of the shell with its left side, bearing the external mantle flap, more deeply buried. The ovigerous "disk" extends to the right of the opening in the shell when viewed from the point of attachment (Fig. 1, 2).

Methods.—The study of this barnacle requires certain special methods because of its habit of living inconspicuously on the inside of the shell. The shell has to be broken to check for the presence of the barnacles, which are found to be almost totally confined to the body whorl. They are situated largely on the "floor" of the inside of the shell (with the apex upwards). Thus the tip or apex of the shell can readily be removed with a geologist's pick or chipping hammer without injury to the occupants. It is most satisfactory to remove the apex gently with the hermit crab alive and still in the shell. The crab is then pushed out of the shell with a bent wire or other probe.

If the shells cannot be opened soon after collection, they may be placed in 10 per cent formalin and kept for a short time. After such treatment the crabs may be removed most easily by pulling them bodily from the shell with curved forceps. Detached portions of abdomen may be removed after chipping off the apex of the shell. If the barnacles are to be saved, the crabs should be removed as soon as possible to allow the fixing fluid to penetrate to the barnacles.

The barnacles are located by a "candling" process in which the shell is illuminated from the apertural side by a narrow beam of light and viewed from the removed apical end. The barnacles appear as yellow, orange, or at times reddish areas with a definite outline, the latter depending upon their age. Very small ones appear as slitlike spots of light.

The adult barnacles adhere quite firmly to the shell, in part because they are cemented to it and in part through the action of the "teeth" or "thorns" by which they abrade the shell. The barnacles can be freed from the shell by placing them in a dilute (1 per cent or less) solution of hydrochloric acid in 70 per cent alcohol for a few days. Von Ebner's decalcifying fluid is also satisfactory. In a few days the overlying shell can be carefully picked away and the barnacle lifted out. Bouin's fluid is excellent for removing the larger barnacles in perfect condition, but many of the smaller animals are lost. In using this fixative the shells are covered with fluid

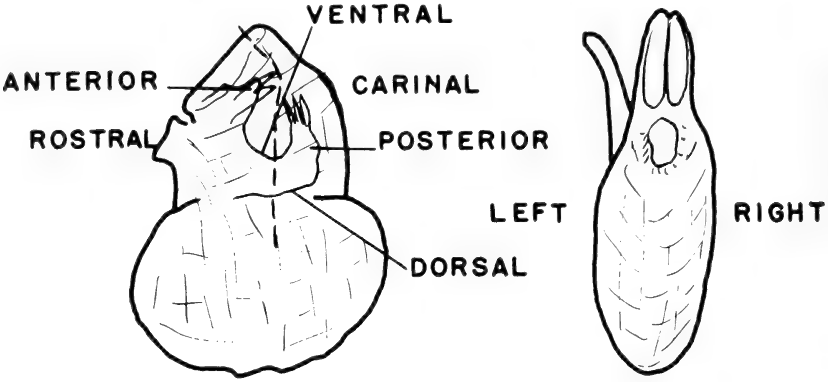

Fig. 3.—The orientation of *Trypetesa lateralis*.

until they are quite soft, which may require several changes of fluid. Jeweler's forceps are valuable in removing the smaller barnacles.

The collecting of the shells in the field was done under varying conditions of tide level and of depth at which the crabs were found. All

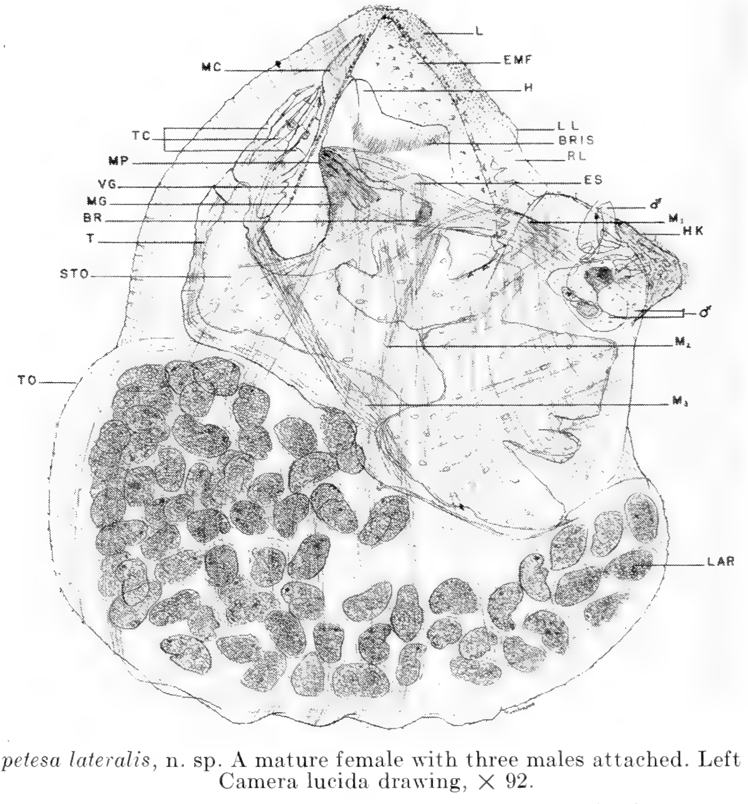

Fig. 4.—*Trypetesa lateralis*, n. sp. A mature female with three males attached. Left lateral view. Camera lucida drawing, × 92.

ABBREVIATIONS USED IN FIG. 4.

BR—Brain.
BRIS—Bristles on the side of the head.
EMF—External mantle flap.
ES—Esophagus.
H—Head.
HK—Horny knob.
L—Lip of the mantle.
LAR—Larva.
LL—Left lip.
LMF—Left internal mantle flap.
$M^{1,2,3}$—Muscles (numbered).
MC—Mouth cirrus.
MG—Maxillary gland.
MP—Mouth parts.
RL—Right lip.
STO—Stomach.
T—Thorax
TC—Thoracic cirri.
TO—Tooth.
VG—Ventral ganglion.
♂—Males.

hermit crabs were collected at random, with no selection for crab or shell types. The differences in the composition of these collections may be seen in Table 1.

Several hundred living *Tegula brunnea* and *T. funebralis* were collected at Moss Beach, San Mateo County, and inspected for specimens of *Trypetesa,* but none were found. Likewise examination of several hundred *Mytilus californianus* shells, living and dead, and of several specimens of large balanoid barnacles from the Monterey Peninsula revealed no *Trypetesa.*

The life cycle.—An analysis of the numbers and sizes of *Trypetesa lateralis* from collections at Moss Beach, San Mateo County, at different times of the year has been made to determine the life cycle. The percentage infection of shells, the average number of barnacles per infected shell, the percentage of larvae in the population, and the average size of the barnacles has been plotted (Fig. 6). Larval-sized barnacles have a slit length of 0.25 mm; when the barnacle starts to mature the slit rapidly becomes longer.

The results seem to indicate that the period of greatest larval settling is during the months of November, December, and January, and again to a lesser degree in June. An increase in the numbers of barnacles per infected shell and the percentage of larvae, with a concommitant decrease in the average barnacle size, give evidence for this larval settling. The drop in the percentage infestation of shells may indicate the breakdown of older shells with larger barnacles, resulting in a decrease in the average size and the increase in the percentage of larva. In the latter case the number of barnacles per infected shell should not increase, which it does. This increase favors the argument for the actual influx of larvae rather than the breakdown of shells.

The recruitment of young barnacles must be very rapid, for during the period of study the percentage of larval-sized barnacles did not fall below 50 per cent. This would imply a very high mortality of barnacles in proportion to the rate of growth. The data are not adequate for a determination of this factor. The life cycle of this barnacle is intimately associated with the length of time that the host shell remains intact. Information on this subject would be of great interest.

The growth of the females of *Trypetesa lateralis* is accompanied by molts, but distinct molt stages or instars are not evident from available data. The results of measurements of 152 barnacles along two axes have been plotted (Fig. 7). The diameter of the lips and disk was

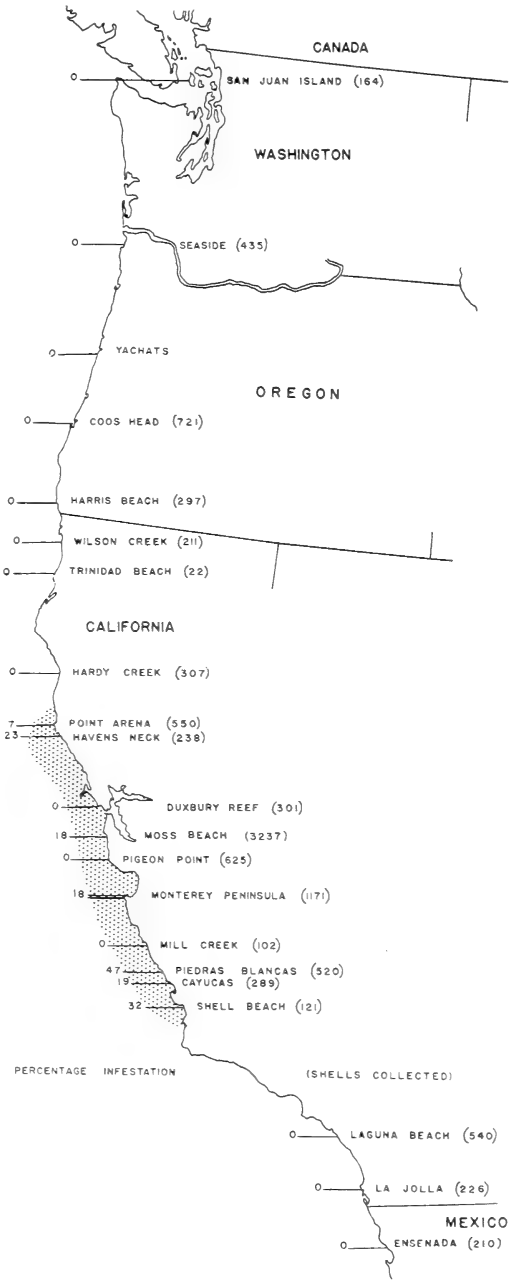

Fig. 5.—Distribution of *Trypetesa lateralis* in the western United States littoral. The shaded area indicates the range. The figures at the left indicate the percentage of infestation, while the figures in parentheses at the right denote the number of shell specimens collected. The double line at the Monterey Peninsula indicates extensive collections at several points.

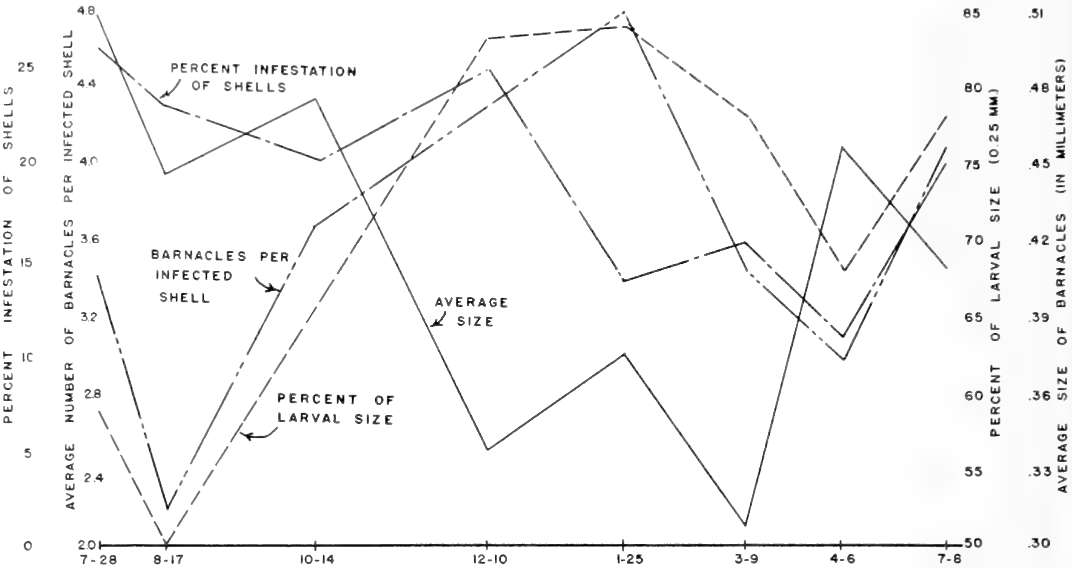

Fig. 6.—Analysis of barnacle numbers and sizes at Moss Beach at different times of the year. The *per cent larval size* is the percentage of the total barnacle sample which was of larval size, or 0.25 mm in slit length. The numbers on the abscissa indicate the month and day, 1951 to 1952.

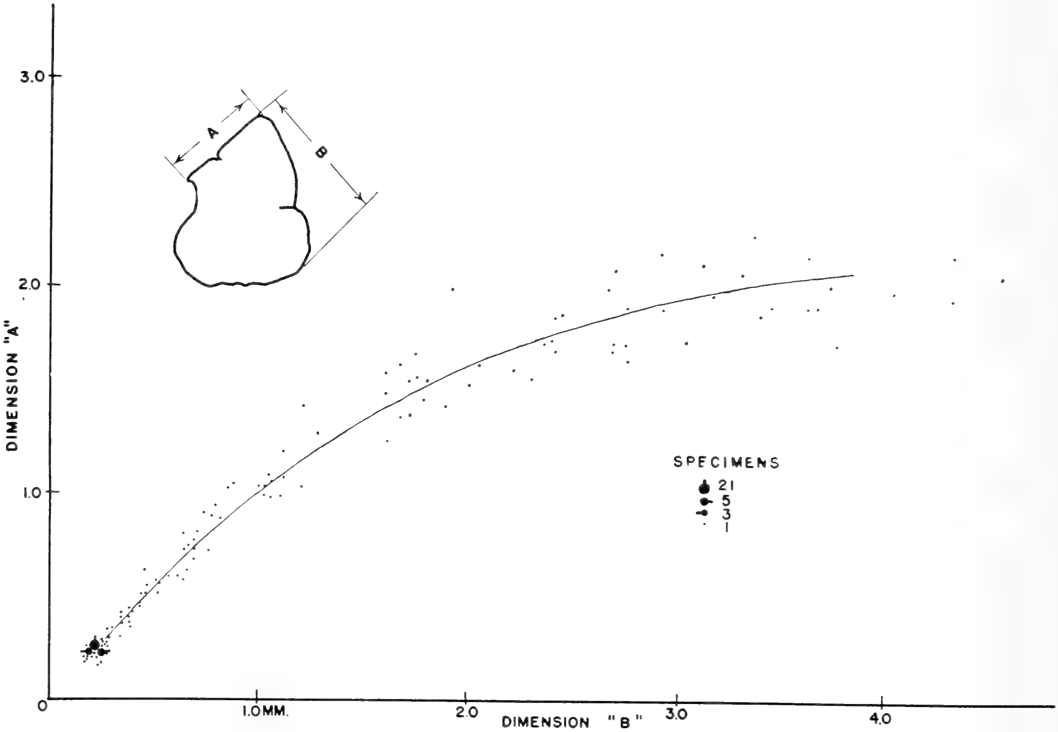

Fig. 7.—Bidimensional growth. A growth curve obtained by plotting lengths "A" and "B" on 2 axes. In all, 152 specimens (a mixed sample) were measured. Different areas, plotted separately, did not give a significant difference.

measured from the distal (carinal) notch of the mantle slit to the furthest corner of the horny knob (dimension "A"). The body diameter was measured perpendicular to the plane of the outside edge of the lip and knob to the opposite edge of the reproductive fan at the widest point (dimension "B"). The growth curve obtained by plotting these two measurements shows that the slit (dimension "A") grows rapidly at first during the juvenile stage, while the reproductive fan (dimension "B") grows markedly during adulthood. No grouping of the results is obtained, however, to warrant the designation of larval instars.

LITERATURE CITED

BERNDT, W. *Zur Biologie und Anatomie von* Alcippe lampas *Hancock.* Zeitschr. Zool. **74:** 396–457. 1903.

———. *Über das System der Acrothoracica.* Arch. Naturg. **73:** 287–289. 1907.

TABLE 1.—ANALYSIS OF INFECTED AREAS

	Tegula funebralis Total shells	With barnacles	Per cent infected	*Tegula brunnea* Total shells	With barnacles	Per cent infected	Miscellaneous shells	With barnacles	Per cent infected	Total shells	Total shells with barnacles	Total per cent infected
Point Arena 2/24/52												
gran	162	3	2	49	7	14	6	0	0	217	10	5
hemp	3	0	0	8	2	25	0	0	0	11	2	18
hirs	56	4	7	8	0	0	2	0	0	66	4	6
sam	230	12	5	6	3	50	6	0	0	242	15	6
unkn	11	0	0	3	2	67	0	0	0	14	2	14
	462	19	14	74	14	19	14	0	0	550	33	6
Havens Neck 8/7/51												
gran	67	0	0	11	6	55	1	0	0	73	6	8
hemp	30	5	17	64	34	58	0	0	0	94	42	45
sam	38	2	5	3	0	0	2	0	0	43	2	5
unkn	14	0	0	12	3	25	2	0	0	28	3	11
	143	7	5	90	43	48	5	0	0	238	53	22
Moss Beach												
7/28/51	58	15	26	116	30	26	0	0	0	174	45	26
8/17 *Low* gran	4	0	0	98	18	18	0	0	0	102	18	57
rest	2	0	0	17	7	41	0	0	0	19	7	37
	6	0	0	115	25	22	0	0	0	121	25	21
High gran	1	0	0	18	3	17	0	0	0	19	3	16
sam	41	5	12	97	32	33	0	0	0	138	37	27
	42	5	12	115	35	30	0	0	0	157	40	25
Total	48	5	10	230	60	26	0	0	0	278	65	23
10/14/51	126	26	21	412	80	19	2	0	0	540	106	20
12/10 *Low*	10	0	0	239	56	24	2	0	0	251	56	22
High	27	4	15	167	52	31	0	0	0	194	56	29
	37	4	11	406	108	27	2	0	0	445	112	25

Table 1—*Continued*

	Tegula funebralis Total shells	With barnacles	Per cent injected	*Tegula brunnea* Total shells	With barnacles	Per cent infected	Miscellaneous shells	With barnacles	Per cent infected	Total shells	Total shells with barnacles	Total per cent infected
1/25/52 gran	14	0	0	401	52	13	3	1	33	418	53	13
sam	10	1	10	15	4	27	0	0	0	25	5	20
unkn	3	0	0	20	7	35	0	0	0	23	7	30
	27	1	37	436	63	14	3	1	33	466	65	14
3/9	104	16	15	485	78	16	4	0	0	593	94	16
4/6	99	12	12	382	41	11	5	0	0	486	53	11
7/8	120	23	19	135	29	21	0	0	0	255	52	20
Total	619	102	16	2602	489	19	16	1	6	3237	592	18
Monterey County, July 1951												
Point Pinos	528	90	17	127	20	16	1	0	0	656	110	17
Point Joe	27	8	30	40	10	25	0	0	0	67	18	27
Fan Shell Beach	26	9	35	20	7	35	1	0	0	47	16	34
Pescadero Point	18	0	0	12	3	25	2	2	100	32	5	16
Mission Point	25	1	4	5	0	0	0	0	0	30	1	3
	624	108	17	204	40	20	4	2	50	832	150	18
Piedras Blancas 8/5/51												
gran	131	23	18	162	97	60	1	0	0	294	120	41
sam	168	80	48	58	47	81	0	0	0	226	127	56
unkn	10	6	60	9	4	44	0	0	0	19	10	53
	309	109	35	229	148	65	1	0	0	539	257	48
Cayucas 9/16/51												
	278	54	19	9	0	0	2	0	0	289	54	19
Shell Beach 8/6/51												
gran	45	7	16	5	2	40	3	1	33	53	10	19
sam	60	28	47	6	2	33	2	0	0	68	30	44
	105	35	33	11	4	36	5	1	20	121	40	33
Total	1875	387	21	2278	608	27	24	4	17	4177	999	24.0

ABBREVIATIONS USED IN TABLE 1

ber—Pagurus beringanus.
gran—P. granosimanus.
hemp—P. hemphillii.
hirs—P. hirsutiusculus.
sam—P. samuelis.
unkn—Unknown.
* —Whelk type of shell.
† —Tegula ligulata.

BLYTH, EDWARD. *Mr. Blyth's monthly report for December meeting, 1842. Appendix to Mr. Blyth's report.* Journ. Asiat. Soc. Bengal **13:** 384. 1844.

BURMEISTER, H. *Beitrage zur Naturgeschichte der Rankenfusser.* Berlin, 1834.

DARWIN, CHARLES. *A monograph on the subclass of Cirripedia:* 529–586. Ray Society, 1854.

GENTHE, K. W. *Some notes on* Alcippe lampas *and its occurrence on the American Atlantic shore.* Zool. Jahrb. Anat. **21:** 181–200. 1905.

GRUVEL, A. *Monographie des cirrhipedes:* 310–335. Paris, 1905.

GERSTÄCKER, A. *Arthropoda,* in Bronn's *Klassen und Ordnungen* **5:** 406–589. 1866.

HANCOCK, A. *Notice of the occurrence, on the British coast, of a burrowing barnacle belonging to a new order of the class Cirripedia.* Ann. Mag. Nat. Hist. **4**(2): 305–314. 1849.

KRUGER, PAUL. *Cirrepedia.* in Bronn's *Klassen und Ordnungen* 5:1:3:3. 1940.

KUHNERT, L. *Beitrag zur Entwicklungeschichte von* Alcippe lampas *Hancock.* Zeitsch. Morphol. Ökol. **29:** 45–78. 1934.

NORMAN, A. M. *New generic names for some Entomostraca and Cirripedia.* Ann. Mag. Nat. Hist. **11**(7): 367–369. 1903.

STRAND, E. *Miscellanea nomenclatorica zoologica et palaeontologica. I–II.* Arch. Naturg. **92A** *Crustacea:* 40–41. 1926.

ZOOLOGY.—Polydora nuchalis, *a new species of polychaetous annelid from California.*[1]

KEITH H. WOODWICK, Allan Hancock Foundation, University of Southern California. (Communicated by Waldo L. Schmitt.)

The spionid worm described herein is the tenth species of *Polydora* to be reported from California (for others see Hartman, 1941). Although resembling several other species in some characteristics, the worm is clearly and consistently different; it is therefore described as a new species.

Polydora nuchalis, n. sp.

The body is generally depressed; it is most so at the modified fifth segment where it is more than twice as wide as deep. It is less depressed in front of and behind this segment. The body tapers posteriorly just before the terminal flaring pygidium. The range observed in the number of segments is 80 to 110; in millimeters of length 15 to 20. In life this polydorid is translucent yellow in color, some individuals having a smoky surface pigmentation in the anterior two-thirds of the body and in the pygidial region. The palpi lack pigment granules but are colored bright red by the blood as are the mid-dorsal and midventral lines and the branchiae of living specimens.

The prostomium is bifid anteriorly and extends posteriorly as the caruncle to the forward margin of the third setigerous segment [third segment below] (Fig. 1, b). A median nuchal tentacle, on which the specific name is based, arises from the prostomium at the level of the first segment. Two pairs of eye spots in a trapezoidal arrangement are found near the palpal bases. The posterior ones are closer together and slightly smaller than the anterior pair. The palpi are long and extend back to the twentieth segment in preserved specimens. The peristomium flares to each side of the prostomium; it is bounded above by the latter and in front and ventrally by the oral aperture.

The first segment lacks notosetae; the parapodia are represented by notopodial and neuropodial lobes and a neuropodial fascicle of setae (Fig. 1, a). The neuropodial lobe and setae are oriented on a line with the notopodial lobes of the succeeding segments. The short, first notopodial lobes are located dorsally just behind the palpal bases.

The next three segments have well-developed notopodial and neuropodial postsetal lobes and fascicles of long slender setae. The notopodial fascicle has two rows of setae including an anterior row of short limbate and a posterior one of longer capillary setae. This notopodial arrangement continues through segments 6 to 9. The neuropodia of segments 2 to 4 have capillary setae.

Segment 5 (Fig. 1, a) is larger than either the fourth or the sixth segment; it lacks postsetal lobes. Its notopodium has a bundle of anterior dorsal capillary setae and a slightly curved single series of large spines alternating with as many companion setae. The spines are largest anterodorsally and are gradually reduced in size posteriorly. They are weakly falcate in shape (Fig. 1, d); the companion setae are

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[1] Contribution no. 119 from the Allan Hancock Foundation, University of Southern California, Los Angeles, Calif. This study was aided by the personnel and made possible through the use of the facilities of the Allan Hancock Foundation.

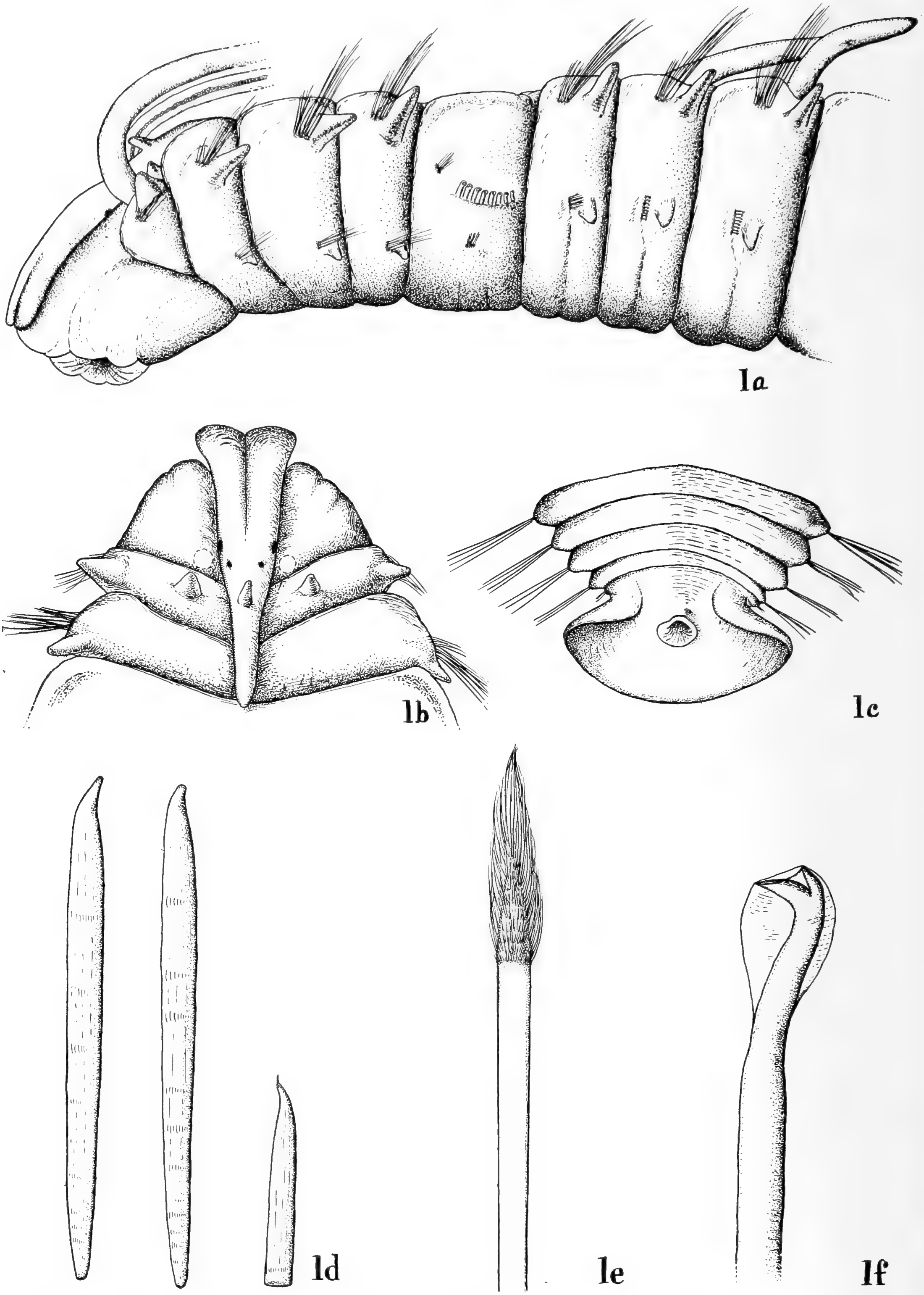


FIG. 1.—*Polydora nuchalis*, n. sp.: *a*, Anterior end, in left lateral view, × 53; *b*, anterior end, in dorsal view, × 53; *c*, pygidium, in posterior dorsal view, × 53; *d*, stout spines of the modified fifth segment showing new, worn, and developing spines, × 122; *e*, companion seta of the modified fifth segment, × 529; *f*, ventral hooded hook from the seventh segment, × 710.

plumose (Fig. 1, e). The neuropodium of segment 5 is vestigial; it has a fascicle of short capillary setae.

Segment 6 resembles segments 2 to 4. Segment 7 differs abruptly in having the beginning of the branchiae dorsally and the hooded hooks ventrally (Fig. 1, a). The vertical series of hooded hooks vary in number from 8 to 6; the anterior segments have the greater number. The hooks are distally bidentate. The main tooth forms an angle with the shaft of approximately 90° and an acute angle with the accessory tooth (Fig. 1, f). (See Söderström, 1920, p. 41, for method of angle measurement.) The notopodial lobes decrease in size from segment 7 to 15. They are small, papillar behind segment 15.

The branchiae are finger-shaped and overlap at the middorsal line. They are full-sized from segment 7 to the posterior fourth of the body There is a gradual reduction in size from this point. There are no specialized posterior notopodial spines or hooks. The pygidium is broad and flaring; it has a wide dorsal notch (Fig. 1, c). The anus is situated slightly dorsal of center.

This species resembles *Polydora cirrosa* Rioja (1943, pp. 233–238, figs. 8–25) in many characteristics but varies from it in the following features: (1) The caruncle extends only to the third instead of the fifth segment; (2) a neuropodial fascicle is present, not absent, in the fifth segment; (3) the notopodial lobes of the first segment and the median nuchal tentacle are short, never cirriform, even in mature specimens; (4) the stout spines and companion setae of the fifth, and the ventral hooded hooks are different.

Polydora nuchalis is also close to *Polydora ligni* Webster (1886, pp. 148–149, pl. 8, figs. 45–47) from which it differs by the following characteristics: (1) It lacks, instead of has, an accessory tooth on the stout spines of the modified segment; (2) the caruncle extends only to the third, instead of to the fourth, segment; (3) the hooded hooks differ.

It also resembles *Polydora websteri* Hartman (1943, pp. 70–72, figs. 1, a–h) but varies from it in that: (1) The caruncle extends only to the third, instead of to the fourth, segment; (2) it has a median nuchal tentacle; (3) the stout spines and companion setae of the fifth segment are different.

Holotype.—U.S.N.M. no. 24724, from Playa del Rey, Calif.

Distribution.—*P. nuchalis* occurs abundantly in the lagoon at Playa del Rey, Los Angeles County, Calif.

Biology.—The water of the lagoon at Playa del Rey varies considerably in salinity owing to alternate seasonal rains and evaporation. This species tolerates these varying salinities. It constructs mucus-lined tubes that are externally covered by a thin layer of sand; they penetrate the substratum to a depth of one or two inches. Associates in the lagoon are *Streblospio benedicti* Webster, *Capitella capitata* (Fabricius), and the amphipod *Corophium insidiosum* Crawford. A fiddler crab, *Uca crenulata* (Lockington), is abundant near the water's edge.

The eggs of *P. nuchalis* are deposited in transparent mucous capsules. The capsules are oriented in rosarylike chains and are individually attached to the wall of the tube by two strands which are continuations of the capsular material. Each capsule has as many as 100 eggs. Only one to eight of the eggs in each capsule develop into larvae; the remaining ova serve as food for the encased larvae. The latter ordinarily reach the 9–12 segmented stage before being freed from the capsule. A short planktonic life may precede settling and tube building.

LITERATURE CITED

HARTMAN, OLGA. *Some contributions to the biology of Spionidae from California.* Allan Hancock Pacific Exped. **7:** 289–324, 4 pls. 1941.

———. *Description of* Polydora websteri, *n. sp.* In Loosanoff, V. L., and J. B. Engle. Biol. Bull. Woods Hole **85:** 70–72, fig. 1, a–h. 1943.

RIOJA, E. *Estudios anelidologicos VIII. Datos acerca de las especies del genero* Polydora *Bosc. de las costas Mexicanas del Pacifico.* Anal. Inst. Biol. Mexico **14:** 229–241, 25 figs. 1943.

SÖDERSTRÖM, A. *Studien über die Polychaeten Familie Spionidae.* Dissertation. 286 pp., 1 pl., 174 figs. Uppsala. 1920.

WEBSTER, H. *The Annelida Chaetopoda of New Jersey.* Annual Report New York State Mus. Nat. Hist., **39:** 128–159, 7 pls. 1886.

ZOOLOGY.—*A new species of polychaete worm of the family Ampharetidae from Massachusetts.*

Marian H. Pettibone, University of New Hampshire, Durham, N. H. (Communicated by Fenner A. Chace, Jr.)

In working over the polychaetous annelids in the Woods Hole region, a new species of ampharetid was found in a salt pond—James Pond on Martha's Vineyard, Mass. It is referred to the genus *Hypaniola* Annenkova, which previously contained a single species, namely, *Hypaniola kowalewskii*, known from the Caspian Sea. *Hypaniola*, as well as the closely related *Hypania* Ostroumov and *Parhypania* Annenkova, includes species noted for their euryhaline properties. The new species is named in honor of Milton Gray, who collected the specimens. The types are deposited in the U. S. National Museum (no. 24734).

Family Ampharetidae

Genus Hypaniola Annenkova, 1927; char. emend.

Type species: *Hypaniola kowalewskii* (Grimm, 1877) Annenkova, 1927, in Caspian Sea. Prostomium trilobed, with or without glandular crests (without in type species; a variable character depending on amount of folding?), with two eye spots. Retractile oral tentacles smooth (not pinnate). Paleae present but poorly developed, delicate, inconspicuous. Branchiae three or four pairs, fused basally. Without pair of dorsal hooks posterior to branchiae (as in *Melinna*). Notosetae begin on segment 3, present on 17 thoracic segments. Notopodia without cirri. Thoracic uncinigerous pinnules begin on segment 6 (setigerous segment 4). Thoracic uncini with a vertical row of teeth. Abdominal uncini with three vertical rows of teeth (type species) or a single row (*H. grayi*). Abdominal uncinigerous pinnules without cirri (type species) or with cirri (*H. grayi*). Pygidium without anal cirri. Nephridia 3 pairs, in segments 4–6 (setigerous segments 2–4).

Hypaniola grayi, n. sp.

Fig. 1, A–M

Size.—Length 9–15 mm., greatest width 1–1.5 mm.

Description.—Body inflated anteriorly, tapered gradually to a narrower posterior end (Fig. 1, A). Body wall thick, opaque, and distinctly segmented on ventral side; very thin, transparent, iridescent, and indistinctly annulated on dorsal side. Prostomium trilobed, the median lobe widest anteriorly, may be flat (in life, Fig. 1, E) or somewhat folded so as to form a more depressed median part and lateral longitudinal crests (Fig. 1, B); basal part a transverse raised area with a pair of lateral eyespots; lateral lobes encircle the median lobe laterally and posteriorly. First achaetous or buccal segment extended ventrally forming a rounded lobe under the prostomium, as long as the next three segments (Fig. 1, B–C). Oral tentacles may be completely retracted within the mouth or more or less extended; they are digitiform, smooth, up to 20 in number, in pairs arranged dorsoventrally on a somewhat folded tentacular membrane, longest and largest near midline, gradually becoming smaller and shorter laterally (Fig. 1, D).

Second or paleal segment with a raised ridge into which the prostomium and buccal segment may be partially withdrawn, the ridge being especially prominent middorsally (Fig. 1, B–C, F); with first pair of branchiae and weakly developed paired lateral bundles of paleal setae. Paleae in each bundle seven or eight in number, forming a spreading bundle, small, very delicate, iridescent, tapering gradually to slender capillary tips, as long as the thoracic notosetae but more delicate (easily overlooked). Segments 3–5 (thoracic setigerous segments 1–3) short, crowded, with cylindrical notopodia bearing notosetae, and with the next three pairs of branchiae. Branchiae four pairs, subequal, long, tapering, subulate, first pair on paleal segment, second pair more laterally on first setigerous segment, third pair more dorsally on second setigerous segment (second and third branchiae almost in transverse line due to crowding of setigerous segments 1–2), fourth pair on setigerous segment 3, in line with the first pair (Fig. 1, A–C, F). The bases of the four branchiae form a close group, with their basal portions distinct but fused to one another on the paleal segment.

Thoracic region with cylindrical notopodia containing bundles of notosetae on 17 segments (beginning on segment 3; Fig. 1, A, C, H–J). Notosetae widest basally, tapering gradually

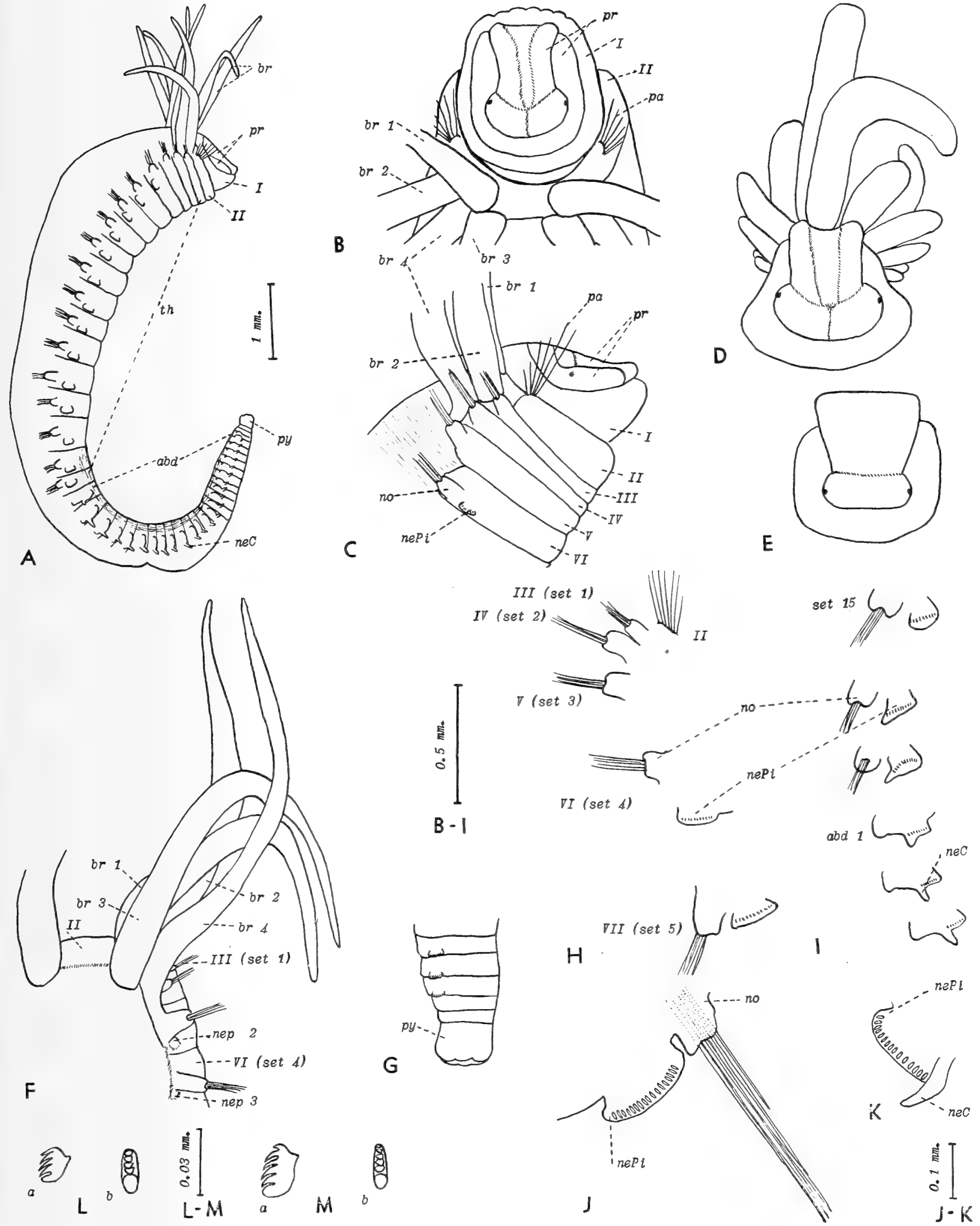


FIG. 1.—*Hypaniola grayi*, n. sp.: A, Lateral view entire animal; B, dorsal view prostomium, first two segments, and bases of branchiae; C, lateral view anterior end, with bases of branchiae only shown; D, dorsal view prostomium and extended oral tentacles; E, dorsal view prostomium (sketched in life); F, dorsal view right group of branchiae and first few thoracic segments; G, lateral view posterior end; H, parapodia of first few segments from right side; I, parapodia of last few thoracic segments and first few abdominal segments from right side; J, parapodium from thoracic region; K, parapodium from abdominal region; L, thoracic uncinus, (*a*) lateral view, (*b*) frontal view; M, abdominal uncinus, (*a*) lateral view, (*b*) frontal view. (*abd*, abdominal uncinigerous segment; *br*, branchia; *neC*, neuropodial cirrus; *nep*, nephridial papilla; *nePi*, neuropodial uncinigerous pinnule; *no*, notopodium; *pa*, paleal setae; *pr*, prostomium; *py*, pygidium; *set*, setigerous segment; *th*, thoracic setigerous segment; *I*, first or buccal segment; *II*, second or paleal segment; *III*, third or first thoracic setigerous segment, etc.)

to slender capillary tips. Thoracic neuropodial uncinigerous pinnules begin on segment 6 (setigerous segment 4); pinnules without cirri or may be short cirri on upper parts of pinnules on few of more posterior thoracic segments (Fig. 1, H–I). Thoracic uncini pectiniform, with four teeth in a single row above the rounded basal part (Fig. 1, L). Abdominal region with achaetous remnants of notopodia on about first six abdominal segments (Fig. 1, I), with uncinigerous pinnules on 22–25 segments (may have one or two achaetous posterior rings; Fig. 1, G), with neuropodial cirri on upper parts of pinnules (Fig. 1, I, K); abdominal uncini pectiniform, with five teeth in single row above rounded basal part (Fig. 1, M). Pygidium short, rounded, without papillae or cirri, may be somewhat lobulated (Fig. 1, G). Anus terminal. Posterior end, including pygidium and last few uncinigerous segments, may be turned inside. Nephridial papillae 3 pairs, posterior to notopodia on segments 4–6 (setigerous segments 2–4; Fig. 1, F).

Color: in life, greenish with whitish spots; in alcohol, colorless or slightly brownish. Tube several times the length of the animal, rather straggly, composed of debris and few light-colored sand grains or may be composed mostly of light-colored sand grains and a small amount of debris.

Remarks.—*Hypaniola grayi* differs from *H. kowalewskii* (Grimm, 1877; see Annenkova, 1927, 1929; known from the Caspian Sea) as follows: The prostomium is shaped differently; there are four pairs of subequal branchiae (*H. kowalewskii* has three or four pairs of branchiae; when the fourth pair is present, it is rudimentary); the abdominal pinnules have cirri (without in the Caspian species); abdominal uncini with five teeth in a vertical row (in *H. kowalewskii*, uncini with 15 or 16 teeth in three vertical rows).

Locality.—James Pond (salt pond), Martha's Vineyard, Mass., found by digging in sandy mud under water, collected by M. B. Gray, August 8, 1950, August 25, 1951, and August 21, 1952. It was found along with other polychaetes, as *Haploscoloplos fragilis* (Verrill), *Heteromastus filiformis* (Claparède), and *Polydora ligni* Webster.

REFERENCES

Annenkova, N. *Über die pontokaspischen Polychaeten. I. Die Gattungen* Hypania *Ostroumov und* Hypaniola, *n. gen.* Ann. Mus. Zool. Acad. Sci. URSS. **28:** 48–62, 1 pl. 1927.

———. *Über die pontokaspischen Polychaeten. II. Die Gattungen* Hypaniola, Parhypania, Fabricia *und* Manayunkia. Ann. Mus. Zool. Acad. Sci. URSS. **30:** 13–20, 2 pls. 1929.

MALACOLOGY.—*Review of the living species of* Echinochama. David Nicol, U. S. National Museum.

A few months before the publication of my paper on *Echinochama* (1952), I received 10 specimens of the genus from Dr. H. S. Lopes, of the Instituto Oswaldo Cruz, Rio de Janeiro, Brazil, and Dr. C. N. Gofferjé, of the Museu Paranaense, Curitiba, Brazil. The material was collected on the coast of the State of Santa Catarina, Brazil. Besides the fact that these specimens extend the recorded range of the genus considerably, they are also distinctive enough morphologically to be considered a heretofore undescribed species. This paper contains a description of the new species and a review of the living species of the genus as well as its geographic distribution.

Genus **Echinochama** Fischer, 1887

Type species.—(Monotypy) *Chama arcinella* Linné, 1767. Recent, Caribbean Sea.

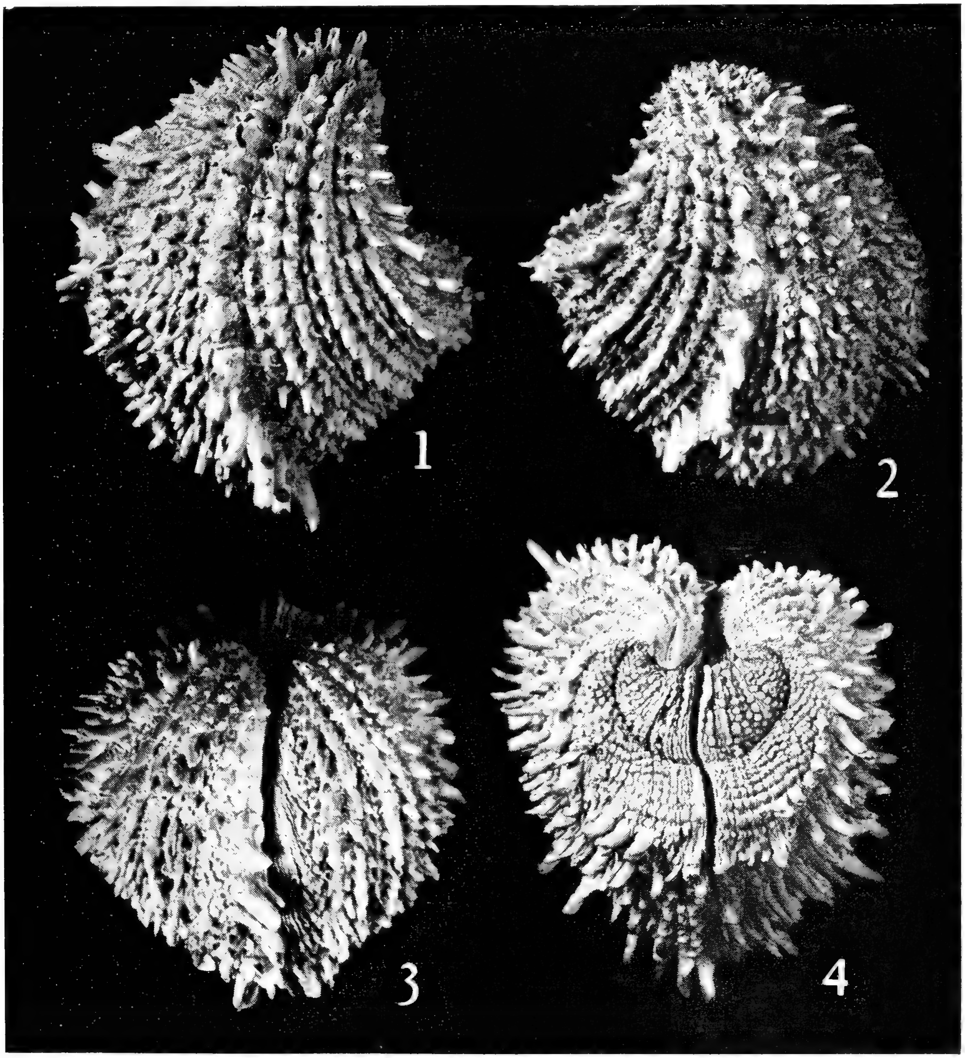
Echinochama brasiliana Nicol, n. sp.

Figs. 1–4

Description.—Shell thick, large; generally higher than long; ratio of convexity to height 0.80; number of spine rows from 18 to 29, averaging 24 for 10 specimens; spine rows closely spaced and most spines small and closely spaced; largest specimen 61.6 mm high, 54.3 mm long, convexity 52.6 mm; smallest specimen 40.5 mm high, 39.7 mm long, convexity 32.0 mm; average height 51 mm; average length 46 mm, average convexity 41 mm.

Comparisons.—*Echinochama brasiliana* is most closely related to *E. arcinella arcinella* but differs from the latter in the following ways: It is larger and has a thicker shell; it is more obese (ratio of convexity to height 0.80 in *E. brasiliana* as compared with 0.75 in *E. arcinella arcinella*); the spine rows are more numerous, and there are more and smaller spines on each row in *E. brasiliana*; the height and length are about equal in *E. arcinella arcinella,* whereas *E. brasiliana* is higher than long. *E. brasiliana* differs from *E. arcinella californica* in the same ways. *E. brasiliana* differs from *E. cornuta* in having a larger number of rows of spines (average 24 as compared to average 10 in *E. cornuta*); *E. brasiliana* also has more numerous small spines.

Types.—The holotype is in the U. S. National Museum, no. 605546; one lot containing two paratypes, no. 603965, and one lot containing one paratype, no. 605771, are also in the U. S. National Museum. Five paratypes have been sent to the Museu Paranaense, Rua Buenos Aires, 200-Curitiba, Paraná, Brazil, and one paratype has been sent to the Instituto Oswaldo Cruz, Rio de Janeiro, Brazil.



FIGS. 1–4.—*Echinochama brasiliana* Nicol, n. sp. Holotype, U. S. N. M. no. 605546; Recent, Ilha do Francês, Santa Catarina, Brazil; × 1; 1, Exterior view, right valve; 2, exterior view, left valve; 3, posterior view, both valves; 4, anterior view showing lunule, both valves.

KEY TO THE RECENT SPECIES OF ECHINOCHAMA

1 Average number of spine rows 10. . *E. cornuta*
Average number of spine rows 20 or more. . 2
2(1) Height and length equal, umbones low, spines generally large. . . . . *E. arcinella*
Higher than long, umbones high, many rows of small spines. . . . . *E. brasiliana*

Geographic distribution.—The new species occurs at the extreme southern end of the range of *Echinochama* in the western Atlantic, and it has been found only off the Ilha do Francês, which is 1,200 meters north of Ilha de Santa Catarina, Santa Catarina, Brazil. According to Dr. Gofferjé (1950, p. 262, and also personal communication), *E. arcinella arcinella* is found on the coast of Paraná, Brazil. Additional collecting may extend the range of the genus still farther south. The accompanying map (Fig. 5) shows the distribution of the living species of *Echinochama*, and a more detailed account of the distribution of the genus is given in my paper (1952, pp. 811–813).

ACKNOWLEDGMENTS

I am greatly indebted to Dr. H. S. Lopes, of the Instituto Oswaldo Cruz, Rio de Janeiro, Brazil, and to Dr. C. N. Gofferjé, of the Museu Paranaense, Curitiba, Brazil, for the gifts of specimens for study. William T. Allen, of the U. S. National Museum, made the photographs for the paper.

REFERENCES

GOFFERJÉ, C. N. *Contribuição à zoogeografia da malacofauna do litoral do Estado do Paraná.* Arq. Mus. Paranaense **8** (7): 221–282, pls. 31–35. 1950.

NICOL, DAVID. *Revision of the pelecypod genus* Echinochama. Journ. Pal. **26** (5): 803–817, pls. 118–119, 15 figs. 1952.

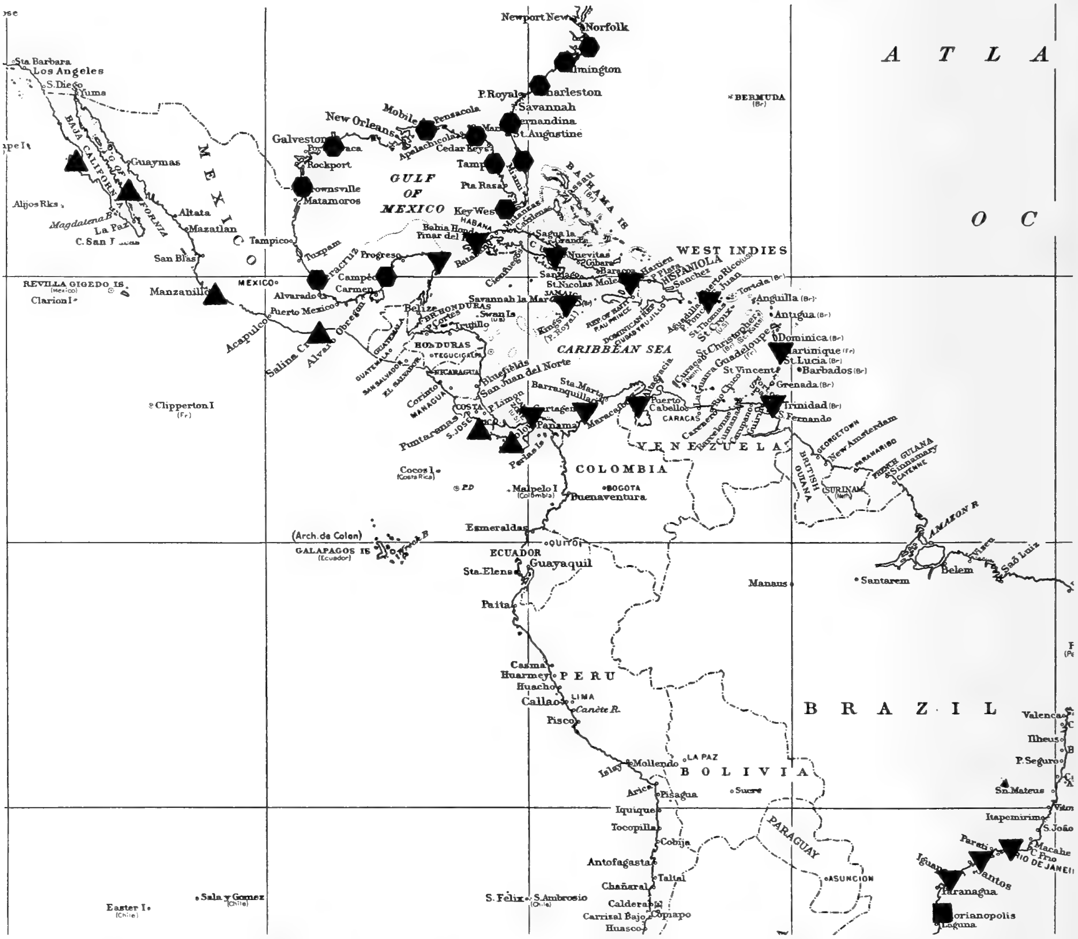


FIG. 5.—Map showing distribution of living species of *Echinochama*. Hexagons—*Echinochama cornuta* (Conrad). downward pointing triangles—*Echinochama arcinella arcinella* (Linné). Upward pointing triangles—*Echinochama arcinella californica* Dall. Squares—*Echinochama brasiliana* Nicol.

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Vol. 43 December 1953 No. 12

ARCHEOLOGY.—*Site patterns in the eastern part of Olmec territory.* Philip Drucker and Eduardo Contreras.

During the spring of 1953, from February to the middle of May, the writers carried out an archeological reconnaissance of the eastern and southern borders of Olmec territory, in the states of Tabasco and Veracruz, Mexico. The study was made possible by a grant from the Wenner-Gren Foundation for Anthropological Research, through which field expenses were provided, and through the cooperation of the Bureau of American Ethnology, Smithsonian Institution, which made the senior author available for the work and provided various items of equipment. In addition, the courteous cooperation of the Instituto Nacional de Antropología e Historia, of Mexico, whose officers granted the necessary work permit and gave letters of introduction to civil and military authorities in the region investigated, is gratefully acknowledged.

The purpose of the work was to attempt to define the extension, on the east and south, of the territory occupied by the archeological culture known as "Olmec." It was essentially a continuation of the archeological program begun a number of years ago by Stirling, in much of which the senior author participated.[1] In the course of that work, during which several major sites were thoroughly tested, a previously unknown Mesoamerican culture was identified, its internal history and relative chronological placing was determined through analysis of its ceramic sequences, and its highly distinctive art style was defined. Nonetheless, the actual geographical extent of the culture had not been determined, except that in its developed phases, at least, it appears not to have extended north of the Papaloapan.[2] The question of territorial extent of the culture during its several periods was brought into relief by recent recognition of obvious Olmec stylistic influence in carved monuments in other parts of Mesoamerica, notably at San Isidro Piedra Parada, Guatemala, and in the Mexican highland, in Morelos and the ceramic and figurine patterns of Tlatilco.[3] If the Olmec patterns, as identified at sites tested in the southern Veracruz-western Tabasco region, could be shown to have extended back from the coast into the adjoining highlands, the distant apparent manifestations of the culture could be more easily accounted for. The problem thus bears on the larger one of the inter-relations of the several Mesoamerican culture centers or *foci*, and the means by which they influenced each other at various periods of their development to bring into being the overall high civilization of the area. In short, the survey here reported on was undertaken in an attempt to contribute to the understanding of basic areal problems.

The survey was designed to cover as much territory as possible in the course of the field season. On the basis of past knowledge

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[1] Stirling, M. W. *Stone monuments of southern Mexico*. Bur. Amer. Ethnol. Bull. 138. 1943; *Stone monuments of the Río Chiquito, Veracruz, Mexico*. Bur. Amer. Ethnol. Bull. 157, Anthrop. Pap. 43 (in press).

Drucker, Philip, *Ceramic sequences at Tres Zapotes, Veracruz, Mexico*. Bur. Amer. Ethnol. Bull. 140, 1943; *La Venta, Tabasco: A study of Olmec ceramics and art*. Bur. Amer. Ethnol. Bull. 153. 1952.

[2] Drucker, Philip. *Ceramic stratigraphy at Cerro de las Mesas, Veracruz, Mexico*. Bur. Amer. Ethnol. Bull. 141. 1943.

[3] Thompson, J. E. S. *Some sculptures from southeastern Quetzaltenango, Guatemala*. Carnegie Institution, Notes on Mid-American Archaeol. and Ethnol. **1:** (17), 1943; Porter, Muriel N., *Tlatilco and the pre-Classic cultures of the New World*. Viking Fund Publ. in Anthropology No. 19. 1953.

of the region and its routes of communication, it was decided that the most efficient means of transport would be use of saddle and pack animals, utilizing watercraft occasionally. Sites found would be test-pitted sufficiently to obtain small ceramic samples, on the basis of which they might be classified as to cultural affiliation, and, where there were features such as complexes of mounds that seemed to have significance, they were to be sketch-mapped. The locations of sites found were to be pinpointed by celestial observations, since available maps of the region show little topographic detail and are often inaccurate.

The field party consisted of Drucker and Contreras, with two Tabascan arrieros and laborers, plus various local guides and laborers. In the course of just over 100 days in the field, the party traveled an estimated 1200 kilometers of trail and river, located 80 archeological sites, and collected approximately half a ton of ceramic samples. The pottery collections were crated and shipped in small increments as frequently as the occasion offered, to the Museo Nacional de Mexico, to relieve the burden on the pack animals. Special thanks are due the director of the museum, Dr. Eusebio Dávalos H., for his kindness in receiving these small-lot shipments and having them stored pending our return to Mexico. Contreras took charge of the mapping part of the project, as well as a good share of the test-pitting; his sketches will be presented in the final report on the work. The least successful part of the project was that referring to determining site locations by celestial observations. Probably because of the mode of transport, the two watch-chronometers carried refused to settle down to uniform rates during the trip, thus adding a variable error factor to the observations.

The procedure followed was to establish temporary quarters, usually at some ranch or in some village, where pasturage could be obtained for the livestock and the party's gear left in someone's custody, and then visit the sites in the vicinity in the course of the next couple of days. Often, to save time, we split our small force, Drucker examining some sites and Contreras the others. One of the chief reasons for making our bases at modern villages and ranches was the constant need for local information. It is probable that archeologists who have not worked in this type of terrain do not appreciate how dependent one must be on local guides, to find sites. A great part of the area surveyed is covered with heavy vegetation, either virgin jungle or second growth bush. One could easily ride within a few meters of a second La Venta, or a second Uaxactun, for that matter, and never know it was there. We did find a few sites that were situated in cleared pasture lands, or that lay squarely across the trail, but we were taken to most of the archeological zones by local people. We found this information to be for the most part accurate and freely given. Only in a few instances did people, apparently suspicious of our motives, refuse to tell us of sites or to show them to us.

The track of the party is shown on the accompanying map. We set out from Huimanguillo, Tabasco, heading westward out of the Grijalva basin, then proceeding downstream along the Río Zanapa, with the general plan of circling to the northward of the Laguna Rosario. At one point we doubled back to visit some localities on tributaries of the Zanapa, then crossed into the watershed of the Río San Felipe, which we followed to the Laguna del Carmen, on the Gulf coast. Retracing our course, we returned to the Zanapa, then turned southward, west of the Laguna Rosario, to the town of San Francisco Rueda, on the railroad. From this point we crossed overland to the Río Pedregal, and proceeded upstream into the mountains. On our return from this jaunt, we crossed overland to San José del Carmen, on the Río Tancochapan (which farther downstream becomes the Río Tonalá), then traveled up the Río de las Playas to the foothill country. We also made a couple of short trips by launch downstream from San José. Next, we crossed overland to the Río Uzpanapa, followed that river up to the edge of the foothills, then back down to the village of Chichigapan. Leaving the Uzpanapa, we crossed overland to the Coatzacoalcos drainage. We traveled upstream to the tributary Rio Jaltepec and the railroad town of Jesús Carranza, then back downstream, terminating the trip at Minatitlán.

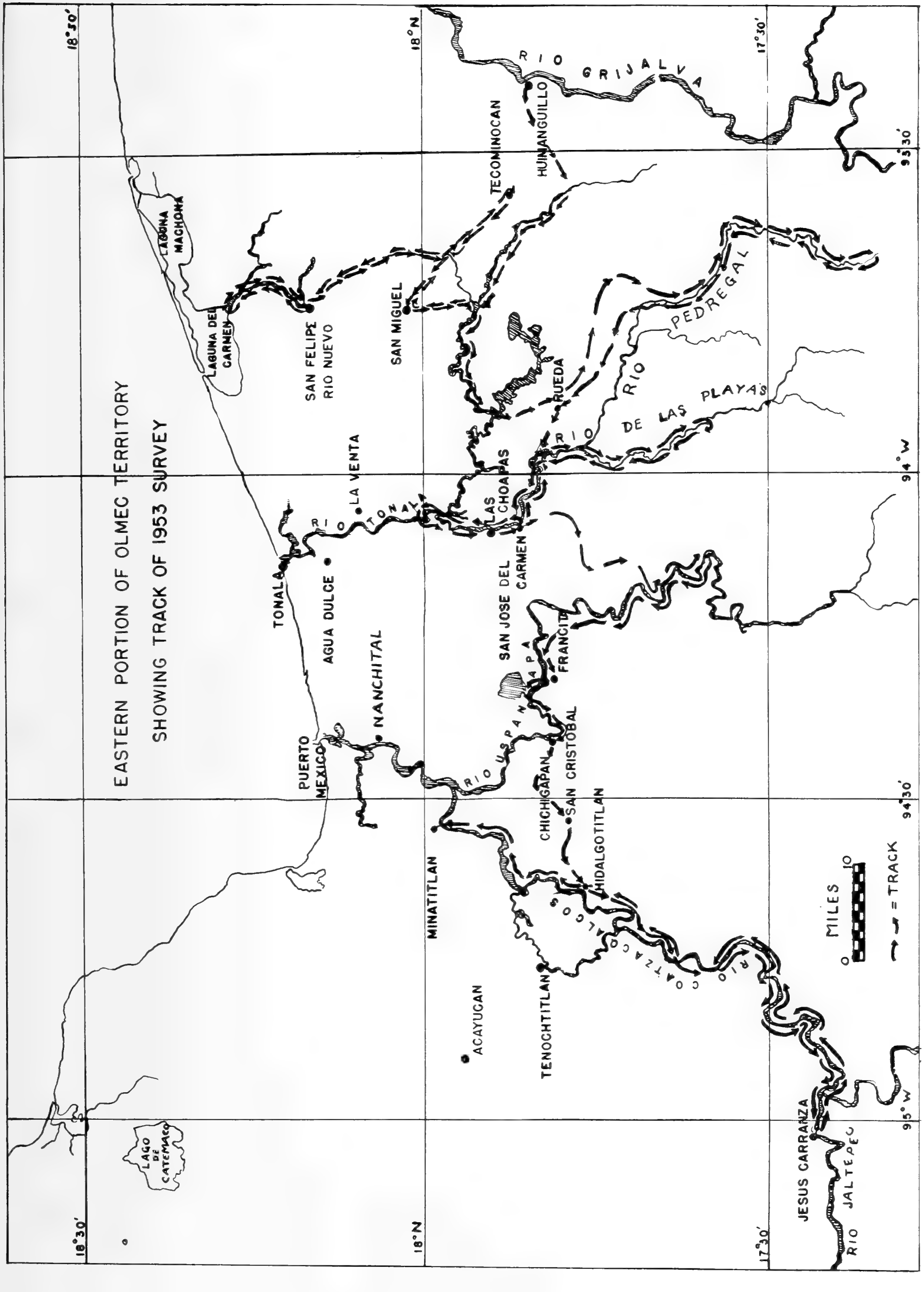
EASTERN PORTION OF OLMEC TERRITORY
SHOWING TRACK OF 1953 SURVEY
18°30'
18°N
17°30'
93°30'
94°W
94°30'
95°W
RIO GRIJALVA
TECOMINOCAN
HUIMANGUILLO
LAGUNA MACHONA
LAGUNA DEL CARMEN
SAN FELIPE RIO NUEVO
SAN MIGUEL
RUEDA
RIO PEDREGAL
RIO DE LAS PLAYAS
LA VENTA
RIO TONALA
LAS CHOAPAS
SAN JOSE DEL CARMEN
TONALA
AGUA DULCE
NANCHITAL
FRANCITA
RIO USPANAPA
SAN CRISTOBAL
CHICHIGAPAN
HIDALGOTITLAN
PUERTO MEXICO
MINATITLAN
RIO COATZACOALCOS
TENOCHTITLAN
ACAYUCAN
LAGO DE CATEMACO
JESUS CARRANZA
RIO JALTEPEC
MILES
0
10
= TRACK

FIG. 1

While this coverage seems fairly extensive—and in the course of the trip it seemed a long, long road at times—it must be recognized that the coverage is by no means complete. For one thing, we did not cover the coastal area and the lower reaches of the rivers between the Laguna del Carmen and the Coatzacoalcos. Much of this region is, and was, uninhabitable swamp, but there are undoubtedly elevated areas on which archeological sites occur. Nor did we investigate the low but rugged hilly region between Las Choapas and Nanchital, although we had some reports of sites there. These two stretches were left out of the itinerary as we came to realize that the allotted time would not permit us to traverse them and the area to the south as well. Consequently, since our problem related to searching for the boundaries of the Olmec area, and not just finding sites in what was probably the heartland of the culture pattern, we deliberately bypassed these sections to concentrate on what seemed to be the border region. Another sector that was slighted is that lying between the middle courses of the Uzpanapa and the Coatzacoalcos. There are probably a good many sites in the section, but because of the sparse population and few trails, it is difficult of access. It seemed advisable, owing to the lateness of the season, to by-pass this region and to concentrate, instead, on the middle course of the Coatzacoalcos. In effect, we by no means pretend to have located all the sites in the region covered. We do believe, however, that we secured a good sampling of sites, especially in the zones critical to our problem. The region west and northwest of the Coatzacoalcos, including the San Juan and Tesechoacan drainages, according to the original plan was left for another season.

A brief sketch of the regional geography must be given, since there are so few data published on it. Most of the coastline in this part of Mexico consists of sandy beaches behind which lies a belt of high dunes, although this dune belt may be quite narrow, as for example at the Laguna del Carmen. Neither beaches nor dune belt offer much inducement to human habitation, the former because of the pounding they get by heavy seas during the "nortes" or northerly storms, the latter because of soil poverty and scarcity of water (although in recent years there has been considerable increase in settlement in the dunes, connected with coconut plantations). South of the dune belt lie the swamps, bordered by dense growths of mangrove along the watercourses. Here and there elevated areas occur, islandlike, amid the swamps, and such places are commonly occupied today, and were also used for human habitation in the past. Intermediate between the swamps and dry-land areas are the locally termed "acaguales." These are tracts that flood during the wet season, and dry out, or partly dry out, during the dry half of the year. The natural vegetation is a dense tangle of scrub and vines, a prominent member of which is a small palm armed with quantities of vicious spines, mixed with large trees. These acaguales, when cleared, become the "potreros" or dry season pastures (in this part of Mexico, at least, the term potrero invariably refers to pastures that flood part of the wet season), but probably had little utility except as hunting areas prior to the introduction of animal husbandry in the area. As one proceeds inland, and to the westward as well, elevated hilly lands become both more frequent and larger. La Venta, of course, is situated on such a structure; there is a larger and quite broken area farther down the Tonalá where the oil town of Agua Dulce is, and the entire stretch transected by the road from Las Choapas to Nanchital consists of low but quite rough hills. In other places the swamps extend inland much farther. From the railroad between Rueda and San José del Carmen one can see an immense stretch of swamp to the northward, interrupted only by the mangrove galleries along the Zanapa and the Blasillo rivers. Beginning a short distance west of Huimanguillo, between the Zanapa and the Pedregal, is a strip of arid plains, locally termed "sabanas." These are characterized by a thin layer of dark gray surface soil, apparently containing a large proportion of very fine sand, overlying clays with great amounts of gravel and sand mixed into them. Apparently this soil profile is so porous that the soils have extremely poor water-holding capacity, and are totally unsuitable for agriculture, either modern or ancient. The terrain is gently rolling, with numerous streamlets bordered by narrow gallery-forests. These savannahs are now used for grazing for the weeks or months that the potreros are flooded but they will not even support good pasture grasses; cattle lose considerable flesh during the few weeks they are kept there.

This discussion of soils and agricultural qualities of the savannahs is stressed, because we believe that this strip formed a barrier to Olmec expansion southward in this part of the region. We could find no trace of archeologic remains in the plains, with the exception of two small sites (one visited, and one only reported) on the northern shores of the Laguna Rosario.

South of the savannahs are a series of hills and ridges, and then a low-lying belt of acaguales (and now mostly potreros) that extends to the rather abrupt edge of the foothills.

South of San José del Carmen, between the Rio de las Playas and the Rio Uzpanapa, there is a strip of savannah that merges into hilly country as one proceeds inland. This is a somewhat peculiar section for it is for the most part very poorly watered, and consequently, seems to have been sparsely inhabited in the past, and has only few inhabitants today. It may be that the two rivers and their tributaries, like the Arroyo Mancuernillas which is said to head far back in the mountains, cut off the drainage from the mountains. The area between the Uzpanapa and the Coatzacoalcos, at least as much as we saw of it, is quite rugged, but has more year-around brooks and streams.

Along the major stream courses, above the edge of the swamp lands, there are extensive stretches of potreros, interrupted at intervals by ridge systems that parallel the course of the river. Many of these suggest remnants of older eroded structures; many have, in places, but shallow soil with frequent outcrops of sandstones and limestone. Others consist of coarse gravels, and perhaps are old gravel-bars. Modern settlements are almost invariably situated on and along such ridges where they occur close to the river bank, the rivers providing the chief communication routes of the region. It is only the newer villages established along rail lines and the new highways that are to be found any distance from the rivers.

In the course of the survey, 80 sites were located, and of these, 71 were tested. Ceramic samples were not collected at all the 71 sites tested, however, for at some of them no sherds could be found. At others, sherds were quite scarce; at still other sites they were abundant. This varying frequency of sherds raises a number of questions as to occupation patterns and/or duration of occupation which will be discussed in subsequent paragraphs. Wherever possible, the samples were taken from what appeared to be normal depositional areas, between and around the mounds. Testpits were dug in mounds only as a last resort, when occupational zones could not be found. The point to avoiding mound samples where possible was of course that one can never be sure just how much of the ceramics included in the mound-fill was contemporaneous with the construction, and how much of it came originally from earlier occupational deposits scraped up to get aggregate for the mound.

At the present writing, the pottery samples are somewhere en route from Mexico to Washington. Until they have been analyzed, nothing can be said as to cultural and temporal affiliations of the sites. However, there were certain variations in site patterns which were revealed by the survey that have interesting implications. These will be described and discussed briefly.

Previous investigations of Olmec sites have made clear that the major centers are characterized by earth mounds, including both conical (originally pyramidal?) and long forms, some of which are scattered about apparently irregularly, but some, and usually the larger structures, are arranged according to some obviously preconceived plan. Frequently, sets of long and conical mounds form quadrangular enclosures, or "plazas." At La Venta the arrangement is not quite so obvious, but nonetheless exists: the major features, mounds and stone monuments, are oriented along a single line, which is just a few degrees off true north. The sites Stirling has called "Rio Chiquito," and "San Lorenzo," near Tenochtitlan, Veracruz, have several large quadrangular "plazas" and so do several subsidiary sites in the vicinity of Tres Zapotes. Presumably, such arrangements had some ceremonial significance or function.

Other sites occur in which earth mounds of various sizes were built in no obvious relationship to each other, that is, they appear to be arranged without any plan. Whether this interpretation as to lack of planning is correct, or whether the structures were spaced according to some abstruse scheme, these sites certainly present an appearance quite different from those of the preceding class.

Mention should be made of the small mounds usually found in the vicinity of the larger structures. These are usually roughly elliptical in plan (perhaps they were more or less quadrangular originally), 10 to 14 m long by 5 to 8 m wide, and from 0.3 m to about 1 m high. Such structures have not been observed to occur in obviously planned arrangements, but are scattered about irregularly, often to one side of, or surrounding, the larger structures. While we cannot offer definite proof, we are of the opinion that these small structures were platforms for dwellings. Many of them are built on today, because of the excellent drainage they provide. We found no sizeable aggregation of these small mounds that did not have one or more larger (ceremonial) mounds associated with it, although the opposite occurs in a few instances: several sites consist of a single conical mound of moderate size with no "house mounds" anywhere about.

Borrow pits are frequently associated with mound groups, particularly in certain parts of our region. These are irregular in shape, and probably were originally rather deep since they have not been filled in by accumulation of vegetal matter and aggradation during the rains.

A third type of site, distinct from the preceding ones, is that which we characterized as a defensive position. This interpretation has not been proved, but is strongly suggested by the nature of these sites: they are usually small, and situated on the very top of some steep little knoll or ridge. The structures consist principally of low long mounds, from just under a meter to about two meters in height, arranged in a rectangle that encloses the flattish top of the hill or ridge. In at least one instance, several flanking mounds had been built on what appeared to have been small prepared terraces some few meters down the slopes. Another distinctive feature of these sites is that the few that we examined were situated at some distance from a river or navigable arroyo. In fact, in no case was there even a non-drying brook, that could have provided water for domestic purposes throughout the dry season, very near at hand. It is conceivable that these may have been seasonally occupied (during the rainy season, of course). Once again we can bring no direct proof, but it seems reasonable enough that a group or groups pushing into a frontier region might begin by establishing seasonally used outposts away from routes of water-communication, in easily defensible positions.

A fourth variety of site encountered was the occupation area, as marked by more or less extensive distributions of sherds on and in the top layers of the soil, with no mounds or other structures. Such deposits occurred consistently in hilly areas, along the slopes and less commonly on top of ridges.

Only one example was found of the fifth type of site, but at least one other is known to occur in the region. This is a non-Olmec pattern, with rectangular house platforms of dry masonry, complexes of earth mounds faced with stone, usually river cobbles, and features that appear to have been ball-courts. In our opinion, these traits indicate affiliation to the cultures of the Chiapas highland, and represent intrusions toward the coastal lowland. The site on the Río de las Playas that Stirling named "La Ceiba" is of this type, according to information and notes that he made available to us, and so is Pueblo Viejo del Pedregal, which we examined.

There are strong suggestions of regional patterning in the distributions of these types. Almost all the sites located along the Rio Zanapa, and along the traverse made to the Laguna del Carmen, in other words, along the eastern border of our region, were of one or the other of the first two types described, that is, of earth mounds including obviously planned complexes, or of mounds in no observable relationship. Sites of these two types were found elsewhere, but along with other types. A distinctive feature noted in some of the sites with planned complexes, both on the Zanapa and elsewhere in the region, not heretofore observed, is that the long mounds forming a quadrangle are sometimes joined, so that the effect is that of a continuous mound forming two or three sides of the enclosure.

Sites with no mounds whatsoever were most common along the Uzpanapa. In four instances a few house mounds were associated with such localities, but the majority of the Uzpanapa sites had no structures of any kind. A few moundless occupational areas were found in the Coatzocoalcos drainage, but were outnumbered there by sites with earth mounds.

The few sites classed as "defensive" were limited to the foothill country of the Pedregal, the Playas, and one locality between the last-named river and the Uzpanapa. If they really were frontier outposts, their locations fit well with known distribution of highland Chiapanecan centers up the Pedregal and the Playas.

Little more can be added to what has already been said about the supposedly highland sites, except to point out that both those presently known (there may be more, for example, up the Uzpanapa and its tributaries), are major centers in every sense: they are quite extensive, and include numerous complexes of structures.

Such diversity of pattern suggests at first glance cultural or temporal differences, or both. However, field inspection of the ceramic samples gave the impression that the majority of the mound sites, with and without obviously planned complexes, and many of the moundless localities, will probably turn out to belong to the Middle Tres Zapotes (or La Venta) horizon. (There appear to be one or more new, hitherto undefined, ceramic complexes at certain of the sites found, also.) If this field impression proves to be correct, it hints that the Olmec must have had, at that time, an extremely complicated ceremonial system, with hierarchies of ceremonial centers serving and being supported by subsidiary communities. At least, it seems reasonable to assume that there was some correlation between size and numbers of ceremonial mounds and the importance of the site.

The sites that lacked ceramic remains present another problem. We encountered most of these localities along the Zanapa. No sherds could be found despite intensive search for them in adjacent land, where occupational debris might have been expected, nor in either the ceremonial nor the house mounds. Absence of sherds in the mounds may have been due in part to heavy reliance on borrow pits as sources of aggregate; borrow pits are fairly common in this part of the region. However, we believe it highly possible that the builders of these structures may have been the first pottery-making occupants of the region. It is essential to add that we do *not* believe that these sites are particularly early; they probably belong to the same La Venta time horizon as neighboring sites from which we collected ceramics. The lack of occupational debris suggests a short period of habitation. Perhaps the people moved to the neighboring localities which for some reason proved to be more suitable for occupancy. To extend our hypothesis a bit further, the foregoing may mean that this Zanapa drainage was a no-man's land into which the Olmec expanded at one phase of their history. How long they utilized it cannot be determined until the collections have been studied. The fact that all the ceremonial sites (to differentiate them from the clusters of house mounds) are small, and the ceremonial mounds themselves tend to be small, seems to indicate that the maximum occupation may have been relatively short.

To summarize, it appears that Olmec culture, through most of its history, was confined to a somewhat smaller region than had been anticipated. Apparently it expanded as far eastward as the middle course of the Rio Zanapa only for a brief period. The savannahs inhibited expansion inland, up the Zanapa and up the Pedregal, and as far westward as the Rio de las Playas. Our present impression, still to be confirmed or disproved by study of the sherd samples, is that at the time of its maximum extent the culture pushed only relatively short distances up the Playas, the Uzpanapa, and the Coatzacoalcos. Whatever the importance of its influences on other Mesoamerican patterns, the Olmec civilization seems to have been restricted to a relatively narrow strip of coast from about the Laguna del Carmen across the swampy lowlands and the rugged Tuxtla mountains to the mouth of the Papaloapan.

BIOCHEMISTRY.—*Investigations concerning the hatching factor of the golden nematode of potatoes,* Heterodera rostochiensis *Wollenweber.*[1]

Louis M. Massey, Jr.,[2] and A. Leslie Neal, Department of Biochemistry and Nutrition, Cornell University. (Communicated by G. Steiner.)

The golden nematode of potatoes or potato eelworm (*Heterodera rostochiensis* Wollenweber) is a plant-parasitic nematode which is responsible for the condition of soil known as "potato sickness." The nematode attacks the roots of the plant causing stunting and a reduction of yield which may be as great as 70 percent. It ranks among the most difficult pests to control. As yet, there is no known method of eradicating this organism once it has become established in a soil.

The life history of the golden nematode is described in Filipjev and Schuurmans Stekhoven, 1941. In brief, subsequent to the organism's invasion of and growth within the roots, the female body is transformed into a small round cyst which may contain from about 10 to 400 eggs. The cysts remain in the soil in a dormant state until exposed to an unidentified substance excreted by the potato root, which serves to stimulate hatching.

The first investigator to study the nature of the stimulant was Triffitt (1930) who found it to be non-volatile and moderately heat resistant. Hurst, as reported by Calam, Raistrick and Todd (1949), prepared a concentrate of the factor from potato soil leachings by evaporation and ethanol extraction procedures and with it was able to induce nematode hatching at a dilution of 1/500,000. Hurst concluded that the factor was an amino acid. Todd and coworkers in a series of publications (Calam, Raistrick, and Todd, 1949; Calam, Todd & Waring, 1949; Marrian, Russell, Todd, and Waring, 1949; Russell, Todd, and Waring, 1949a, 1949b; Marrian, Russell, and Todd, 1949) report attempts to isolate the active material and to synthesize active compounds. These workers concluded that the factor "is an acid probably containing a lactone group" and ascribed the name eclepic acid to this substance. The "high acidity and probable lactonic nature" led them to determine the activity of a number of tetronic acids and related compounds. Among those tested, anhydrotetronic acid was found to possess slight activity.

Investigations dealing with the hatching factor have been undertaken in this laboratory for the purpose of concentrating and identifying the active substance.

EXPERIMENTAL

Collection of leachings.—Tomatoes have been shown to excrete a golden nematode hatching factor which appears to be similar to that excreted by the potato plant (Russell, Todd, and Waring, 1949a). Since it was more convenient to use the former plant our studies have dealt with concentrating the factor from tomato leachings. The collection of relatively small volumes of leaching was accomplished by placing quart size "Sealright" cardboard containers under four-inch pots in which tomato plants were growing and allowing the leachings to drip directly into the containers. The contents of each container were frozen as soon as possible after collection. Frozen leachings have been found to retain their activity after storage periods of at least one year.

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Assay method.—A comparison of the number of larvae hatched when cysts are immersed in solutions containing varying concentrations of the factor has served as a basis for estimating the relative concentration of the active substance (Fenwick, 1949, 1951a, 1951b, 1952; Lownsbery, 1951). The method used in this study is a slight modification of that developed by Lownsbery (1951) for testing the viability of larvae contained in nematode cysts.

A crude preparation of cyst material was obtained from heavily infested soil by flotation methods. The product was then air dried at room temperature and stored in a 50 percent relative humidity atmosphere. This crude preparation contained in addition to chaff, seeds, etc., approximately 7,000 cysts per g.

Aqueous extracts of this crude cyst material possessed slight hatching activity which appeared to be associated with the chaff constituent. Therefore, the chaff was removed by rolling the crude cyst material down a glass tube of 3 cm inside diameter and approximately 1 m in length. The tube which was fitted with a glass baffle about 10 cm from one end was inclined approximately 10° from horizontal, baffle end uppermost. Approximately 1 g of the crude cyst material was introduced into the upper end of the tube and the cysts and other spherical objects rolled out of the chaff by slowly rotating the tube around its longitudinal axis. The resulting material contained approximately 15,000 cysts per g and was found to be free from chaff.

Twenty mg of the chaff-free cyst material containing approximately 250 cysts were placed in a petri dish, and 20 ml of the solution to be assayed were then added. After an incubation period of 14 days at 21°C., the number of cysts present and the larvae which hatched were counted with the aid of a low power microscope. Since the number of cysts per dish is variable and a few larvae hatch from cysts placed in water, a distilled water blank as well as a solution of the initial leachings were incorporated in each assay for comparison purposes. A single source of cysts was used for an individual assay. The results are expressed as the number of larvae hatched per 100 cysts.

Concentration of the hatching factor.—Leachings were lyophilized at approximately 70 microns pressure and the residue extracted five times with 400 ml portions of absolute ethanol each time. The combined ethanolic extracts were then concentrated to 25 ml under 25 mm pressure. A white crystalline precipitate which formed during the concentration was removed by filtration and found to possess no activity. Upon the addition of 5 volumes of peroxide-free diethyl ether to the ethanolic filtrate additional inactive impurities were precipitated. After removal of the precipitate, evaporation of the ethanol-ether solution to dryness under 25 mm pressure left a residue which was not completely soluble in water. Extraction of this residue with 10 ml of distilled water and subsequent lyophilization of the aqueous solution yielded a yellow amorphous substance which is referred to as "concentrate-A."

Paper chromatography.—A study of the distribution of the hatching factor on paper chromatograms was made. Five μl of a solution (192 μg of solids per μl) of concentrate-A was applied to each of several strips of Whatman No. 1 paper (1½ x 25 inches). The strips were developed at 25°C. immediately after the spots had dried. Both ascending and descending developments were tried using 80 percent aqueous phenol, 50 percent phenol in 10 percent aqueous ethanol, and n-butanol saturated with water. After development, the strips were dried at room temperature in forced air for a 24-hour period. Beginning at one-quarter inch below the point of application for ascending developments, or one-quarter inch above the point of application for descending developments, the strips were cut into 1 inch segments and numbered consecutively. Each segment was eluted with 40 ml of distilled water which was subsequently divided into two equal portions for duplicate assays.

For comparison purposes, a "crude concentrate" of the hatching factor was prepared according to the method of Calam, Raistrick, and Todd (1949). Two μl of a solution of this product containing 180 μg of solids was subjected to paper chromatography using 80 percent aqueous phenol as the solvent. The distribution of activity on paper chromatograms of a mixture of the concentrates obtained by the two above procedures was also determined.

Leaf and root tissue preparations.—One hundred leaf punches (1 cm diam.) taken at random from ten six-week old tomato plants were floated upon 250 ml of distilled water in suitable containers and illuminated for periods of one and two days. At the end of each of these periods 20 ml aliquots of the water from each dish were assayed for activity.

One gram samples (fresh weight) of leaf and root tissues were homogenized in a Potter-Elvehjem homogenizer under the following conditions.

1. Homogenized in distilled water at room temperature.
2. Homogenized in absolute ethanol at room temperature.
3. Homogenized in absolute ethanol at 0°C.
4. Steam blanched for 2 min. subsequent to homogenization in absolute ethanol at room temperature.
5. Lyophilized subsequent to homogenization in absolute ethanol at room temperature.

After homogenization the samples were centrifuged and the supernatant solution decanted. Each sediment was thoroughly extracted with absolute ethanol, centrifuged again and the supernatant added to the first extract respectively. These solutions were then evaporated to dryness under 15 mm. pressure and the residue taken up in 25 ml of distilled water for assaying.

RESULTS AND DISCUSSION

The cysts used for any individual assay were from a composite sample obtained from a single source in order to eliminate the difference in the viability of larvae in cysts collected at different times. Generally, during the hatching season duplicate assays did not vary from the mean by more than 10 percent.

All preparations of concentrates obtained possessed activity equivalent to or greater than that of the original leachings when diluted the appropriate amount with distilled water. For example, using duplicate assays the following average number of larvae hatching per 100 cysts were obtained: Distilled water, 200; original leaching, 600; concentrate-A (concentrated 4×10^4 times) diluted 4×10^4 times with distilled water, 805. Since a reliable quantitative assay for the factor was not available at the time these experiments were conducted the extent to which the preparations could be diluted and still exhibit hatching activity was not determined.

It has been observed that caution must be exercised during the process of concentrating solutions of the factor because of its lability towards heat and alkali. These properties are in accordance with those reported for eclepic acid.

The hatching factor was further concentrated by the technique of paper chromatography. Aqueous phenol, 80 percent, was found to be a satisfactory solvent for developing the chromatograms. Ascending developments with this solvent gave considerably sharper separations than did descending developments. Fig. 1 shows the distribution of activity on a typical strip when concentrate-A was developed for a distance of 19¼ inches at 25°C. using the ascending technique with the above solvent. The highest activity was found in the seventeenth segment, corresponding to a R_F value of 0.84. The average R_F value of six determinations was 0.84 ± 0.066. Weight determinations of the dried eluates from the various segments indicated that most of the solids remained in segments 2 to 5, inclusive. For example, after applying 950 μg to a strip, less than 10 μg of active residue was found to be eluted from the seventeenth segment.

The activity on the dry chromatograms was found to be quite rapidly destroyed upon exposure to air at room temperature. Elution immediately following the 24-hour air-drying period resulted in very little if any loss of activity. How-

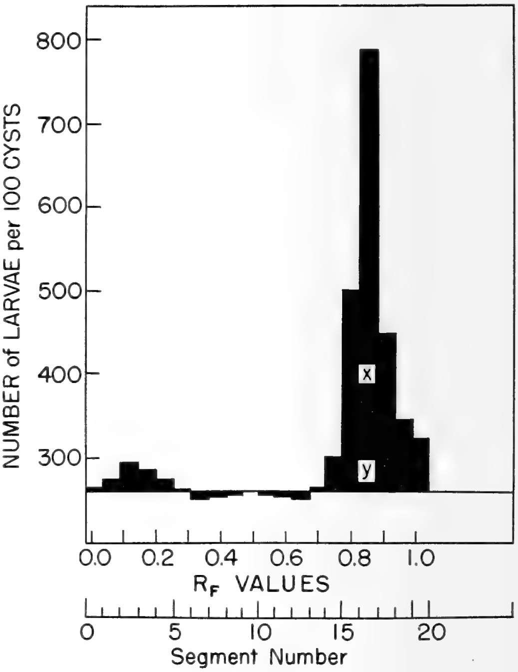

Fig. 1.—Distribution of activity on paper chromatogram of concentrate-A. A total of 950 μg of crude concentrate in 5.0 μl of water was applied to the paper. After development in 80 per cent phenol at 25° C. for a distance of 19¼ inches, the paper strips were dried and cut into one inch segments for elution and assaying. The values represented by X and Y indicate the activity of the most active segment after exposure to the laboratory atmosphere for 2 and 4 days, respectively, following the air-drying period.

ever, approximately 50 to 100 percent loss of activity from the most active segment occurred when the strips were permitted to remain exposed to the laboratory atmosphere for two and four days, respectively, after the drying period (see X and Y, Fig. 1).

The distribution of activity obtained when the crude concentrate prepared according to the method of Calam, Raistrick and Todd (1949), was chromatogrammed is shown in Fig. 2. The peak of highest activity corresponds to a R_F value of 0.83. When mixtures of this preparation and concentrate-A were chromatogrammed there was no change in the R_F value.

Concentration of the factor by continuous ether extraction of an aqueous sulfuric acid solution has been used by previous workers (Calam, Raistrick, and Todd, 1949). From the data presented in Table 1 it is apparent that the extracted material from concentrate-A possesses about the same activity as the non-extracted residue. However, the activity of more purified preparations obtained from paper chromatograms does not appear to be extracted with ether either from an aqueous sulfuric acid solution or directly from the paper chromatogram. The data presented in Table 2 are from a typical experiment in which the most active segments from four paper chromatograms were used. In this experiment 0.98 mg of concentrate-A was applied to each strip. In each treatment where ether was employed it was evaporated off after the extraction and the residue, if any, taken up in 40 ml of distilled water for duplicate assays. For continuous ether extraction the segments were eluted with 7.5 ml water and the solution acidified with 1.5 ml of 2N H_2SO_4. After the extraction period the aqueous phase was neutralized with NaOH and diluted to 40 ml for assaying. The inhibitory effect of Na_2SO_4 is shown by the lack of activity of solutions 2 and 3b (Table 2). This effect was not noted above due to the dilution employed. It is of interest to note the inactivity of the ether extracts (3a and 4a) and the high activity of the aqueous eluate (4b) from the strip which had previously been extracted with ether in a Soxlet apparatus for a period of 12 hours.

The presence of a hatching agent in tomato leaf tissue is indicated by the fact that water upon which leaf punches were floated was found to possess hatching activity. About twice the number of larvae were hatched in the presence of the water upon which illuminated leaf punches were floated for a period of one day as was hatched by an equivalent volume of leachings (see Table 3). At the end of two days illumination there was about an eight fold difference in the number of larvae hatched.

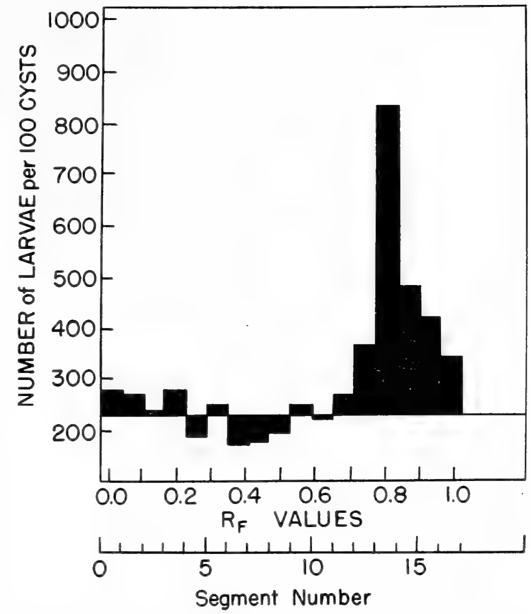

Fig. 2.—Distribution of activity on paper chromatogram of the product prepared by the procedure of Calam, Raistrick and Todd (1949). A total of 27 μg of crude product in 2.1 μl of water was applied to the paper. After development in 80 percent aqueous phenol at 25°C. for a distance of 16⅜ inches, the paper strips were dried and cut into one inch segments for elution and assaying.

The occurrence of a hatching stimulant in tomato leaves was further established by assaying extracts of the homogenized tissue. A comparison of the activity of leaf homogenates prepared under different conditions is presented in Table 4. The activity of root tissue homogenates prepared under the same conditions is also shown. Although the values for the number of larvae

Table 1.—Activity of Ether Extracted Material from Aqueous Sulfuric Acid Solution of Concentrate-A

Fraction	Weight	Concentration of solution assayed	Increase in number of larvae hatched above that of the blank
	grams	*μg/ml*	*per μg/ml of solids*
Ether phase	0.15	1.5	61
Aqueous phase	0.23*	3.5*	71

* Corrected for the Na_2SO_4 formed by neutralizing the H_2SO_4 previous to assaying.

hatched are quite low due to seasonal variations, there is a definite significant difference between several of the treatments and the distilled water blank. In the case of treatments 3, 4, and 5 (Table 4) the activity of the homogenates of both leaf and root tissue was equal to or greater than that of leachings. Steam blanching or lyophilizing the leaf tissue previous to homogenizing in absolute ethanol at room temperature appeared to be the most satisfactory treatment for this tissue. By far the most active root homogenates were obtained when the roots were homogenized in absolute ethanol at 0°C. Homogenates of the tissues in distilled water at room temperature showed no activity in the case of leaf tissue and a slight, if significant, activity in the case of root tissue.

TABLE 2.—ETHER SOLUBILITY OF CONCENTRATES OBTAINED FROM PAPER CHROMATOGRAMS

Treatment of most active segment	Larvae per 100 cysts*
1. Eluted with 7.5 ml distilled water	273
2. Eluted with 7.5 ml distilled water, 1.5 ml of 2N H_2SO_4 added and solution immediately neutralized with NaOH	12
3. Eluted and acidified as in 2, then continuously extracted with ether for a period of 12 hours:	
a. Ether phase	26
b. Neutralized aqueous phase	10
4. Extracted in Soxlet apparatus for a period of 12 hours:	
a. Ether	7
b. Water eluate of segment after ether extraction	244
Distilled water blank	24

* Average of duplicate assays.

TABLE 3.—ACTIVITY OF WATER UPON WHICH ILLUMINATED TOMATO LEAF PUNCHES WERE FLOATED

Assay solution	Larvae per 100 cysts*
Distilled water	1.5
Tomato leachings	16
Water upon which leaf punches were floated:	
1 day illumination	30
2 days illumination	130

* Average of duplicate assays.

TABLE 4.—ACTIVITY OF TOMATO TISSUE HOMOGENATES

Treatment*	Larvae per 100 cysts†	
	Leaf tissue	Root tissue
1. Homogenized in distilled water at room temperature	1.5	5.5
2. Homogenized in absolute ethanol at room temperature	5	8
3. Homogenized in absolute ethanol at 0°C	11	35
4. Steam blanched, homogenized in absolute ethanol at room temperature	16	19.5
5. Lyophilized, homogenized in absolute ethanol at room temperature	16.5	11

Tomato leachings; 11 larvae per 100 cysts.†

Distilled water; 2 larvae per 100 cysts.†

* One gram (fresh weight) of tissue used in each preparation.

† Average of duplicate determinations.

SUMMARY

A method for obtaining a concentrate of the golden nematode hatching factor has been described.

By employing the technique of paper chromatography the factor was found to have a R_F value of 0.84 when 80 percent aqueous phenol was used as the solvent.

In a fairly pure state the factor was found to be ether insoluble.

A hatching agent has been shown to be present in leaf tissue as well as in root tissue of the tomato plant.

LITERATURE CITED

CALAM, C. T., RAISTRICK, H., and TODD, A. R. *The potato-eelworm hatching factor. 1. The preparation of concentrates of the hatching factor and a method of bioassay.* Biochem. Journ. **45**: 513–519. 1949.

———, TODD, A. R., and WARING, W. S. *The potato-eelworm hatching factor. 2. Purification of the factor by alkaloid salt fractionation. Anhydrotetronic acid as an artificial hatching agent.* Biochem. Journ. **45**: 520–524. 1949.

FENWICK, D. W. *Investigations on the emergence of larvae from cysts of the potato-root eelworm* Heterodera rostochiensis. *1. Technique and variability.* Journ. Helminth. **23**: 157–170. 1949.

———. *Investigations on the emergence of larvae from the cysts of the potato-root eelworm* Heterodera rostochiensis. *(4) Physical conditions and their influence on larval emergence in the laboratory.* Journ. Helminth. **25**: 37–48. 1951a.

———. *Investigations on the emergence of larvae from the cysts of the potato-root eelworm* Heterodera rostochiensis. *(5) A shortened method for the conduct of hatching tests.* Journ. Helminth. **25**: 49–56. 1951b.

———. *The bioassay of potato root diffusate.* Ann. Appl. Biol. **39**: 457–467. 1952.

FILIPJEV, I. N., and SCHUURMANS STEKHOVEN, J. H., Jr. *A manual* of agricultural helminthology: 495–642. Leiden, 1941.

LOWNSBERY, B. F. *Larval emigration from cysts of the golden nematode of potatoes,* Heterodera rostochiensis *Wollenweber.* Phytopath. **41**: 889–896. 1951.

MARRIAN, D. H., RUSSELL, P. B., TODD, A. R., and WARING, W. S. *The potato eelworm hatching factor. 3. Concentration of the factor by chromatography. Observations on the nature of eclepic acid.* Biochem. Journ. **45**: 524–528. 1949.

———, RUSSELL, P. B., and TODD, A. R. *The potato eelworm hatching factor. 6. Attempts to prepare artificial hatching agents. Part II. Some active arylidene* -$\Delta\beta:\gamma$-*butenolides and related compounds.* Biochem. Journ. **45**: 533–537. 1949.

RUSSELL, P. B., TODD, A. R., and WARING, W. S. *The potato eelworm hatching factor. 4.* Solanum nigrum *as a source of the potato eelworm hatching factor.* Biochem. Journ. **45**: 528:–530. 1949a.

———. *The potato eelworm hatching factor. 5. Attempts to prepare artificial hatching agents. Part I. Some furan derivatives.* Biochem. Journ. **45**: 530–532. 1949b.

TRIFFITT, M. J. *On the bionomics of* Heterodera schachtii *on potatoes with special reference to influence of mustard on the escape of larvae from cysts.* Journ. Helminth. **8**: 19–48. 1930.

BOTANY.—*Realignments in the Bromeliaceae subfamily Tillandsioideae.*

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It has long been evident that no author has been consistent or logical in delimiting the genera of the subfamily Tillandsioideae of the Bromeliaceae. Virtually all useful phylogenetic characters are limited to the petals, stamens, and pistil, yet available material is so frequently inadequate in these parts, that there is a tremendous temptation to base genera on other characters. The assumption has been that certain habital characters are correlated with floral ones. This is true in a single instance, the absence of spines on the leaves of the Tillandsioideae. All other correlations in the subfamily are incomplete to begin with as in the case of the distichous arrangement of flowers that partially characterizes *Tillandsia* and *Vriesia*, or else they have broken down with the discovery of additional species.

We do not believe in making changes on well established systems such as the latest monograph of the family (Mez in Engler, Das Pflanzenreich IV. **32**) unless something demonstrably better can be offered, but the three genera noted below, *Thecophyllum* André, *Cipuropsis* Ule, and *Chirripoa* Suesseng., are now useless even in an artificial system. Although the generic position of many species must remain in doubt until good flowers are obtained, we are transferring all species on the basis of such evidence as is available. We preface our treatment of *Thecophyllum* and *Cipuropsis* by a concept of *Vriesia* Lindley emended appropriately to include these entities in the sense used by Mez in his last monograph. *Guzmania* requires no emendation to accommodate *Thecophyllum* in the original sense of André.

Vriesia Lindl. emend. Smith & Pittendrigh

Inflorescentia simplex vel paniculata, ea paniculata cum bracteis primariis vel parvis et inconspicuis vel conspicuis et ramos plus minusve obtegentibus; sepalis liberis; petalis vel in tubum brevem sepalis valde superatum connatis vel omnino liberis, appendiculatis; ovario supero vel paulo infero.

Lindley's type species, *V. psittacina*, is gamopetalous, but this fact has been overlooked and the genus characterized as polypetalous, as will be detailed in another paper. As defined above, *Vriesia* contains all the species of the Tillandsioideae with a primary type of gamopetaly, that is, with petals truly fused or connate and not merely agglutinated and more or less interlocking as in the secondary type that characterizes *Guzmania* and *Mezobromelia*. Since it also contains polypetalous species, its basic character remains its appendaged petals.

Thecophyllum André

(Structure of corolla noted where known)

Theccophyllum André, Bromel. Andr. 107. 1889 = **Guzmania** R. & P. Fl. **3**: 37. 1802, in all probability. Of the two original species, the first, *T. wittmackii*, is undoubtedly a *Guzmania*, while the second, *T. poortmanii*, very likely is also although its corolla is still unknown to us. See below.

Thecophyllum André emend. Mez, Bull. Herb. Boiss. II. **3**: 131. 1903 = **Vriesia** Lindl. Bot. Reg. **29**: *pl. 10*. 1843.

T. acuminatum L. B. Smith, Contr. Gray Herb. **117**: 30, *pl.* 2, *figs. 28, 29.* 1937 = **Vriesia attenuata** Sm. & Pitt. nom. nov. Not *Vriesia acuminata* Mez & Wercklé, Bull. Herb. Boiss. II. **4**: 868. 1904. Petals appendaged—LBS.

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[1] This author acknowledges assistance in the course of his work from the Eugene Higgins Memorial Fund, Princeton University.

T. angustum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 1121. 1904 = **Guzmania donnellsmithii** Mez ex Donn. Smith, Bot. Gaz. **35:** 9. 1903. Petals naked, agglutinated—LBS.

T. balanophorum (Mez) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Guzmania balanophora* Mez in DC. Monogr. Phan. **9:** 918. 1896 = **Vriesia balanophora** (Mez) Sm. & Pitt. comb. nov. Petals appendaged, free—LBS.

T. balanophorum var. *subpictum* Suesseng. Bot. Jahrb. **72:** 291. 1942. From the description this appears to be the same as *T. lineatum* Mez & Wercklé. See below.

T. bracteosum Mez & Wercklé, Repert. Sp. Nov. Fedde **14:** 246. 1916 = **Vriesia bracteosa** (Mez & Wercklé) Sm. & Pitt. comb. nov. Not *Vriesia bracteosa* Beer, Bromel. 263. 1857, nomen in synonymy.

T. capitatum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 873. 1904 = **Vriesia capitata** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. capituligerum (Griseb.) L. B. Smith, Contr. Gray Herb. **98:** 14. 1932. *Tillandsia capituligera* Griseb. Cat. Pl. Cub. 254. 1886 = **Vriesia capituligera** (Griseb.) Sm. & Pitt. comb. nov. Petals connate—CSP.

T. comatum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 871. 1904 = **Vriesia comata** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. cornuaultii (André) Mez, Engl. Pflanzenreich IV. **32:** 423. 1935. *Tillandsia cornuaulti* André, Énum. Bromél. 8. Dec. 13, 1888; Rev. Hort. **60:** 568. Dec. 16, 1888 = **Tillandsia turneri** Baker, Journ. Bot. **26:** 144. 1888. See L. B. Smith, Contr. Gray Herb. **104:** 82. 1934. Petals naked, free—André sketch.

T. crassiflorum Mez & Wercklé, Bull. Herb. Boiss. II. **3:** 138. 1903 = **Vriesia crassiflora** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. cylindraceum Suesseng. & Goeppinger, Bot. Jahrb. **72:** 292. 1942 = **Vriesia cylindracea** (Suesseng. & Goeppinger) Sm. & Pitt. comb. nov. The specific name is uncomfortably close to that of *V. cylindrica* L. B. Smith, Contr. U. S. Nat. Herb. **29:** 445. 1951, but we believe it is enough different to obviate the use of a new name.

T. discolor Mez & Wercklé, Repert. Sp. Nov. Fedde **14:** 246. 1916 = **Vriesia discolor** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. dussii (Mez) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903 = **Guzmania dussii** Mez in DC. Monogr. Phan. **9:** 923. 1896. See L. B. Smith, Contr. Gray Herb. **98:** 30, *pl. 5, figs. 13, 14.* 1932. Petals naked, agglutinated—LBS.

T. fastuosum (André) Mez, Engl. Pflanzenreich IV. **32:** 423. 1935. *Tillandsia fastuosa* André, Énum. Bromél. 8. Dec. 13, 1888; Rev. Hort. **60:** 568. Dec. 16, 1888 = **Vriesia capituligera** (Griseb.) Sm. & Pitt. See above. Petals connate—CSP.

T. gloriosum (André) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Caraguata gloriosa* André, Énum. Bromél. 5. Dec. 13, 1888; Rev. Hort. **60:** 565. Dec. 16, 1888 = **Guzmania gloriosa** (André) André ex Mez in DC. Monogr. Phan. **9:** 922. 1896. See André, Brom. Andr. 48, *pl. 17C.* 1889, where the corolla is described as "breviter trilobata"; L. B. Smith, Caldasia **3:** 240. 1945. Petals naked, agglutinated—André figure.

T. hygrometricum (André) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Caraguata hygrometrica* André, Énum. Bromél. 6. Dec. 13, 1888; Rev. Hort. **60:** 566. Dec. 16, 1888 = **Vriesia hygrometrica** (André) Sm. & Pitt. comb. nov.

T. insigne (E. Morren) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Pepinia insignis* E. Morren ex Baker, Handb. Bromel. 142. 1889 = **Tillandsia insignis** (E. Morren) Sm. & Pitt. comb. nov. Petals free, naked—LBS.

T. irazuense Mez & Wercklé, Bull. Herb. Boiss. II. **3:** 138. 1903 = **Vriesia irazuensis** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. johnstonii Mez, Bull. Herb. Boiss. II. **4:** 872. 1904, as *johnstonei* = **Vriesia johnstonii** (Mez) Sm. & Pitt. comb. nov. Petals appendaged, free—CSP.

T. kraenzlinianum (Wittm.) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903 = **Guzmania kraenzliniana** Wittm. Bot. Jahrb. **11:** 62. 1890, where the corolla-tube is noted.

T. kupperi Suesseng. & Goepping. Bot. Jahrb. 72: 292. 1942 = **Vriesia kupperi** (Suesseng. & Goepping.) Sm. & Pitt. comb. nov. According to the International Rules, the above combination is not invalidated by *Vriesia kupperiana* Suesseng. Bot. Archiv Leipzig **39:** 384, *fig. 1.* 1939. Petals originally described as free and appendaged.

T. latissimum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 1122. 1904 = **Vriesia latissima** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. laxum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 1123. 1904 = **Vriesia diffusa** Sm. & Pitt. nom. nov. Not *Vriesia laxa* (Griseb.) Mez in DC. Monogr. Phan. **9:** 578. 1896.

T. lehmannianum Mez, Repert. Sp. Nov. Fedde **16:** 72. 1919 = **Guzmania mosquerae** (Wittm.) Mez in DC. Monogr. Phan. **9:** 924. 1896. See below.

T. lineatum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 875. 1904 = **Vriesia lineata** (Mez & Wercklé) Sm. & Pitt. comb. nov. Petals appendaged, free—LBS.

T. longipetalum (Baker) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Tillandsia longipetala* Baker, Journ. Bot. **26:** 142. 1888 = **Guzmania longipetala** (Baker) Mez in DC. Monogr. Phan. **9:** 919. 1896. See L. B. Smith, Contr. Gray Herb. **104:** 75. 1934. Petals naked, agglutinated—LBS.

T. montanum L. B. Smith ex Yuncker, Field Mus. Pub. Bot. **17:** 319, *pl. 7.* 1938 = **Vriesia montana** (L. B. Smith) Sm. & Pitt. Journ. Washington Acad. Sci. **43:** 69. 1953.

T. mosquerae (Wittm.) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Caraguata mosquerae* Wittm. Bot. Jahrb. **11:** 58. 1889 = **Guzmania mosquerae** (Wittm.) Mez in DC. Monogr. Phan. **9:** 924. 1896. See L. B. Smith, Caldasia no. **5:** 6. 1942.

Petals naked, agglutinated—LBS. Long corolla-tube noted in original description.

T. ororiense (Mez) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Guzmania ororiensis* Mez in DC. Monogr. Phan. **9:** 917. 1896 = **Vriesia ororiensis** (Mez) Sm. & Pitt. comb. nov. Petals described by Mez as free and appendaged in making the combination and in emending *Thecophyllum*.

T. palustre (Wittm.) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Caraguata palustris* Wittm. Bot. Jahrb. **11:** 58. 1889 = **Guzmania palustris** (Wittm.) Mez in DC. Monogr. Phan. **9:** 923. 1896. Corolla-tube noted in original description.

T. paniculatum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 1123. 1904, as *panniculatum* = **Vriesia triflora** Sm. & Pitt. nom. nov. Not *Vriesia paniculata* (L.) Mez in DC. Monogr. Phan. **9:** 614. 1896.

T. pauperum Mez & Sodiro, Bull. Herb. Boiss. II. **4:** 876. 1904 = **Vriesia paupera** (Mez & Sodiro) Sm. & Pitt. comb. nov.

T. pedicellatum Mez & Wercklé, Bull. Herb. Boiss. II. **3:** 136. 1903 = **Vriesia pedicellata** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. pennellii (L. B. Smith) Mez. Engl. Pflanzenreich IV. **32:** 422. 1935 = **Guzmania pennellii** L. B. Smith, Contr. Gray Herb. **98:** 30, *pl. 6, fig. 3.* 1932. Confirmed as a *Guzmania* by a subsequent collection (*Cuatrecasas, Schultes & E. Smith* 12743).

T. pictum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 874. 1904 = **Vriesia picta** (Mez & Wercklé) Sm. & Pitt. comb. nov. Petals appendaged—Mez.

T. pittieri Mez, Bull. Herb. Boiss. II. **3:** 137. 1903 = **Vriesia notata** Sm. & Pitt. nom. nov. Not *Vriesia pittieri* Mez, Bull. Herb. Boiss. II. **3:** 135. 1903. Petals free, appendaged—Mez.

T. poortmanii André, Brom. Andr. 108. 1889, as *poortmani*; Mez, Bull. Herb. Boiss. II. **3:** 131. 1903 = **Guzmania poortmanii** (André) André ex Mez in DC. Monogr. Phan. **9:** 922. 1896, as *poortmani*. Long corolla-tube noted in original description.

T. rubrum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 878. 1904 = **Vriesia leptopoda** Sm. & Pitt. nom. nov. Not *Vriesia rubra* (R. & P.) Beer, Bromel. 98. 1857.

T. sceptrum Mez, Bull. Herb. Boiss. II. **3:** 139. 1903 = **Guzmania gloriosa** (André) André ex Mez in DC. Monogr. Phan. **9:** 922. 1896. See L. B. Smith, Caldasia **3:** 240. 1945.

T. singuliflorum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 870. 1904 = **Vriesia singuliflora** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. sintenisii (Baker) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Caraguata sintenisii* Baker, Handb. Bromel. 145. 1889, as *sintenesii* = **Vriesia sintenisii** (Baker) Sm. & Pitt. comb. nov. Petals appendaged, free—LBS.

T. spectabile Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 873. 1904 = **Vriesia spectabilis** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. splitgerberi (Mez) Pittendrigh, Evolution **2:** 60. 1948. *Guzmania splitgerberi* Mez in DC. Monogr. Phan. **9:** 930. 1896 = **Vriesia splitgerberi** (Mez) Sm. & Pitt. comb. nov. Petals appendaged, connate—CSP.

T. squarrosum Mez & Sodiro, Bull. Herb. Boiss. II. **4:** 877. 1904 = **Guzmania squarrosa** (Mez & Sodiro) Sm. & Pitt. comb. nov. See L. B. Smith, Caldasia no. **5:** 7. 1942.

T. standleyi L. B. Smith, Contr. Gray Herb. **117:** 30, *pl. 2, figs. 30, 31.* 1937 = **Vriesia standleyi** (L. B. Smith) Sm. & Pitt. comb. nov. Petals appendaged—LBS.

T. stenophyllum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 875. 1904 = **Vriesia stenophylla** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. turbinatum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 1122. 1904 = **Vriesia turbinata** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. urbanianum (Mez) Mez, Bull. Herb. Boiss. II. **3:** 131. 1903. *Guzmania urbaniana* Mez in DC. Monogr. Phan. **9:** 920. 1896 = **Vriesia antillana** Sm. & Pitt. nom. nov. Not *Vriesia urbaniana* Harms, Notizblatt **12:** 532. 1935. Petals appendaged—LBS.

T. violascens Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 877. 1904 = **Vriesia violascens** (Mez. & Wercklé) Sm. & Pitt. comb. nov.

T. viride Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 872. 1904 = **Vriesia viridis** (Mez & Wercklé) Sm. & Pitt. comb. nov. Petals appendaged, free—LBS.

T. vittatum Mez & Wercklé, Bull. Herb. Boiss. II. **4:** 871. 1904 = **Vriesia vittata** (Mez & Wercklé) Sm. & Pitt. comb. nov.

T. werckleanum Mez, Bull. Herb. Boiss. II. **3:** 139. 1903 = **Vriesia nephrolepis** Sm. & Pitt. nom. nov. Not *Vriesia werckleana* Mez. Bull. Herb. Boiss. II. **3:** 136. 1903.

T. wittmackii André, Brom. Andr. 107, *pl. 39B.* 1889: Mez, Bull. Herb. Boiss. II. **3:** 131. 1903 = **Guzmania wittmackii** (André) André ex Mez in DC. Monogr. Phan. **9:** 921. 1896. Petals naked, agglutinated—LBS.

André based *Thecophyllum* on two species with free sepals and fascicles of flowers in the axils of large primary bracts. On the basis of a subsequent collection (*Haught* 2897), we know that the first of these, *T. wittmackii*, has the flowers of a *Guzmania*. The description of the second species, *T. poortmanii*, was based on Poortman's sketch of the plant, and as this indicated a long and exserted corolla-tube, there is little doubt that it also is a *Guzmania*.

In 1896, in his first monograph of the Bromeliaceae (DC. Monogr. Phan. **9**), Mez reduced *Thecophyllum* to a subgenus of *Guzmania*, adding 12 more species to the concept and dropping the character of free sepals.

In 1903, Mez discovered that one of these added species, *G. ororiensis*, had the flowers not of a *Guzmania* but of a *Vriesia*. Whereupon he removed them all from *Guzmania* and resurrected *Thecophyllum* as a genus related to *Vriesia* but differing in its aborted branches.

From then until his second monograph (Engler, das Pflanzenreich IV. **32**), Mez added 33 more species including 15 with "ramulis manifestis." These last contradicted André's original basis and required a complicated redefinition of the genus. Although L. B. Smith had reduced the comparably artificial genus, *Sodiroa* (Contr. Gray Herb. **104:** 73), and demonstrated that several supposed species of Mez's *Thecophyllum* were in reality *Guzmania*, he continued with considerable inconsistency to follow Mez's lead in maintaining *Thecophyllum* as a genus (Pflanzenreich IV. **32:** 599–600).

In reducing Mez's concept of *Thecophyllum* to *Vriesia*, we note that so far as flowers are available, all species show the included stamens of the section *Xiphion*, and most of them have also the thick coriaceous sepals so common in this section. As it does not seem possible to separate Mez's *Thecophyllum* as a whole from the previously recognized species of section *Xiphion*, there is no point in trying to maintain it in an infrageneric category. Its merging with section *Xiphion* is logical from a geographical standpoint also, as that is the only section whose area completely surrounds it.

Cipuropsis Ule

Cipuropsis Ule, Verhandl. Bot. Ver. Brandenburg **48:** 148. 1907; Mez, Engl. Pflanzenreich IV. **32:** 598. 1935 = **Vriesia** Lindl. Bot. Reg. **29:** *pl. 10.* 1843.

C. subandina Ule, Verhandl. Bot. Ver. Brandenburg **48:** 149. 1907. *Tillandsia subandina* (Ule) Mez ex L. B. Smith, Contr. Gray Herb. **98:** 16. 1932; in Macbride, Fl. Peru, Field Mus. Pub. Bot. **13:** 556. 1936. = **Vriesia subandina** (Ule) Sm. & Pitt. comb. nov.

The genus *Cipuropsis* was erected by Ule to accept his species *subandina* which he observed had not only petal-appendages but also a gamopetalous corolla. We show above that no real justification existed for such action since *Vriesia psittacina*, the type of Lindley's genus, has the petals both appendaged and joined. Ule clearly took at face value Mez's polypetalous definition of *Vriesia*.

L. B. Smith's transfer of the species to *Tillandsia* was according to Mez's supposed distinction between petal-scales of *Vriesia* with a horizontal line of attachment and vertical calli with auricled apices found in some species formerly placed in *Tillandsia* (see Contr. U. S. Nat. Herb. **29:** 430). The character of gamopetaly was either overlooked or attributed to faulty observation. Later, in his last monograph, Mez accepted *Cipuropsis* as a distinct genus.

As Ule's specimen is not available it is not possible to decide which type of gamopetaly is involved, the primary or true fusion which would make *Cipuropsis* a synonym of *Vriesia* or the secondary or agglutination type which would cause it to replace the later *Mezobromelia.*

Two characters of *Cipuropsis* incline us to place it with *Vriesia* rather than with *Mezobromelia*, the shortness of its corolla-tube and the distichous arrangement of its flowers. In *Vriesia* the corolla-tube, when present, is much shorter than the sepals, in *Cipuropsis* it is described as little more than a fourth as long as the sepals, but in *Mezobromelia* it equals them. In *Vriesia* the flowers are two-ranked with very few exceptions and they are two-ranked in *Cipuropsis*, but not in *Mezobromelia.*

Chirripoa Suesseng.

Chirripoa Suesseng. Bot. Jahrb. **72:** 293, *pl. 4, fig. 11,* 1942 = **Guzmania** R. & P. Fl. Per. **3:** 37. 1802.

C. solitaria Suesseng. Bot. Jahrb. **72:** 293, *pl. 4, fig. 11,* 1942 = **Guzmania polycephala** Mez & Wercklé, Repert. Sp. Nov. Fedde **14:** 254. 1916; L. B. Smith in Woodson, Fl. Panama, Ann. Mo. Bot. Gard. **31:** 116. 1944.

The genus *Chirripoa* is a prime example of the confusion involved in making genera on habital characters, since the author in noting its affinities, compared it to genera in all three subfamilies of the Bromeliaceae. In fact he was so much in doubt that he published it as "nov. genus ad interim" indicating that the name was merely a means of noting the species until its genus could be discovered.

We find that the description and plate of *Chirripoa solitaria* agree closely with *Guzmania polycephala* with one exception. The description gives a greater length for the sepals than for the floral bracts. However, the illustration does not show exserted sepals and we can only suppose that through some error only the exposed apex of the floral bract was measured, disregarding the base covered by the bract below.

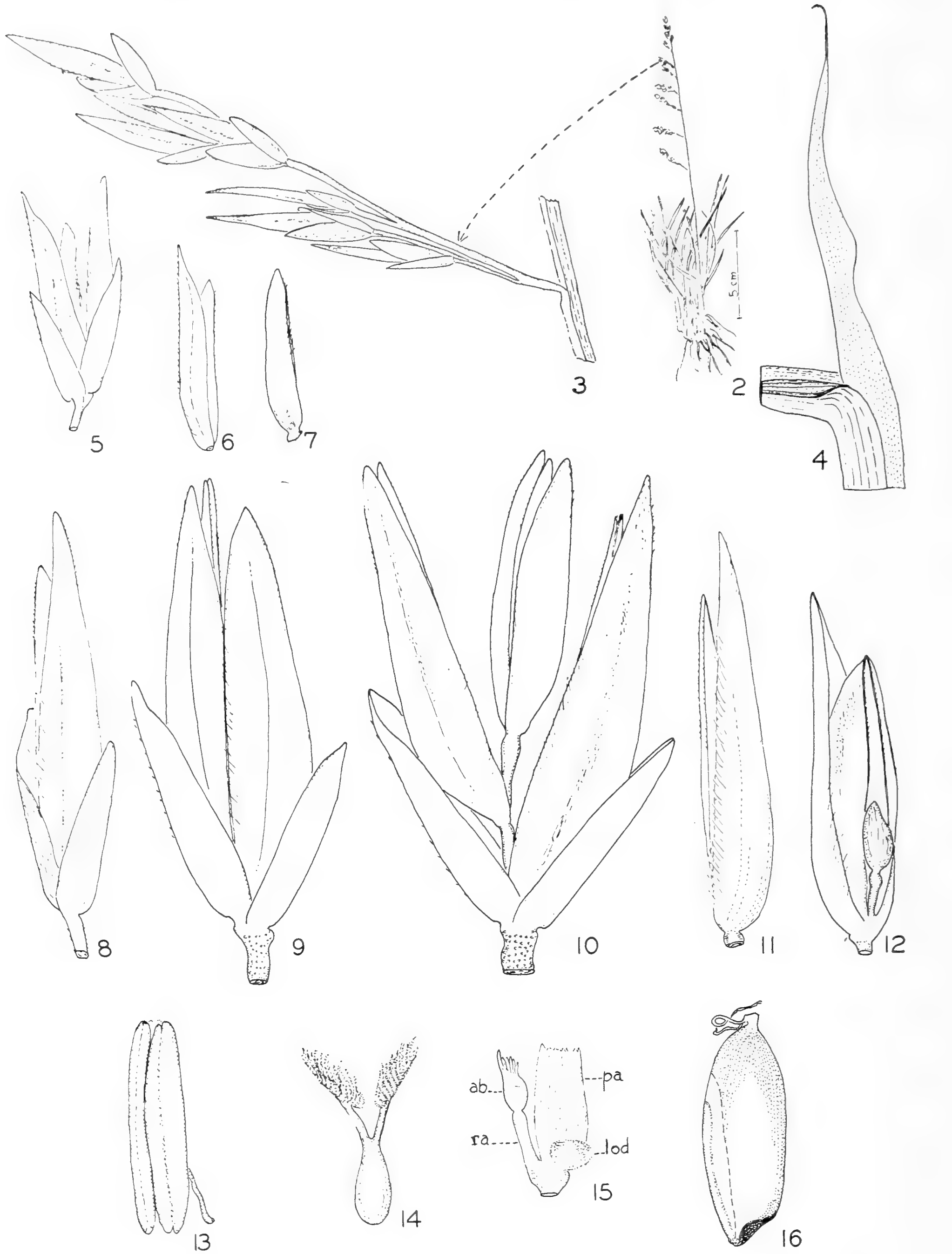
BOTANY.—Chaboissaea ligulata *Fourn.: A Mexican grass*, ERNEST R. SOHNS, U. S. National Museum. (Communicated by Agnes Chase.)

Chaboissaea, a monotypic genus of the tribe Festuceae, is relatively unknown. The genus was described by Fournier (1886) from material collected by Virlet in San Luis Potosí. A portion of the type in the U. S. National Herbarium bears these data: "Chaboissaea ligulata Fourn. Mexique. Prov. de San Luis. Coll. Virlet d'Aoust 1851." This species was collected a second time in 1910 by A. S. Hitchcock "No. 7693, along railway, Sanchez, Chihuahua, Oct. 12, 1910. Alt. 8000 ft." The writer collected this grass at three stations near San Felipe, Guanajuato, in October 1952 (Fig. 1). These plants were growing in hard, rocky, clay soil on the banks of dry irrigation ditches and on the rocky slopes of Cerro del Fraile. Associated species were *Eragrostis diffusa* Buckl., *E. plumbea* Scribn., *Panicum vaseyanum* Scribn., and *Andropogon hirtiflorus* var. *feensis* (Fourn.) Hack.

In its natural habitat this grass suggests a species of *Muhlenbergia* or *Eragrostis*. Perhaps this is the reason it has been infrequently collected. The purpose of this paper is to review the history of the genus and, with additional data from new material, to supplement the original description. It is hoped that this species will be represented more frequently in grass collections from Mexico.

Most taxonomists, after Fournier, treated the genus as a member of the tribe Agrostideae. *Chaboissaea* belongs in the tribe Festuceae. Hackel (1890) listed the genus at the end of his work among the doubtful genera, and he assumed that the Festuceae was the correct tribe. Lamson-Scribner and Merrill (1900) misapplied the name and transferred it to *Muhlenbergia ligulata*, citing two Palmer specimens, nos. 731 and 948 from Durango, these later described as *Muhlenbergia subbiflora* Hitchc. Hitchcock (1913) accepted Lamson-Scribner and Merrill's relegation of *Chaboissaea ligulata* to synonymy under *M. ligulata*. Bews (1929)

FIG. 1.—Map of northern Mexico. Collection localities are indicated by black dots. Type material was collected in San Luis Potosí, no precise locality given.



Figs. 2–16.—*Chaboissaea ligulata* Fourn.: 2, Habit sketch of plant; 3, branch of inflorescence; 4, ligule; 5, 6, and 7, spikelet, floret, and palea, respectively, from the type specimen; 8, 9, and 10, one-, two-, and three-flowered spikelets; 11, floret; 12, floret showing rachilla and aborted floret; 13, anther; 14, pistil; 15, base of floret showing one lodicule (lod), palea (pa), rachilla (ra), and aborted floret (ab); 16, caryopsis. (Fig. 3–7, ×7; 8–16, ×22.) (Drawn from Sohns, nos. 411 and 446, deposited in the U. S. National Herbarium.)

lists the genus as a synonym of *Muhlenbergia*. Conzatti (1946) placed the genus in the Agrostideae and referred the species to *Muhlenbergia ligulata*.

Fournier's (1886) generic description was brief: "Spiculis bifloris, flore inferiore hermaphrodito, superiore minori sterili, paleis integris." One species, *C. ligulata*, was described (and illustrated) as follows: "Culmi glabro filiformi, foliis linearibus mediocribus, ligula lanceolata exserta longa fissa; panicula 10″ longa, contracta, radiis longis compositis alternis remotis basi nudis, spiculis bifloris; glumis inaequalibus, superiore majore; flore inferiore in callo insidente, hermaphrodito, palea inferiore ampla acuminata superiorem superante, margine ciliata, superiore breviter mucronata, staminibus 3, stylis longis, stigmatibus plumosis; flore superiore pedicellato, breviore et angustiore, palea inferiore acuta."

The following emended description is based on my collections from Guanajuato. It is evident that the genus belongs in the tribe Festuceae.

Perennial, caespitose (Fig. 2); culms 10–45 cm tall, glabrous; nodes glabrous; leaves mostly basal; sheaths keeled, glabrous, striate, margins hyaline, shorter than the upper internodes; ligule prominent (Fig. 4), membranous, up to 1 cm long, tip attenuated and splitting when dry; blades 3–12 cm long, glabrous on the lower and scabrous on the upper surface, folded when dry; inflorescence exserted and standing out prominently above the basal blades (in small plants), 6–12 cm long, branches appressed-ascending at first, later spreading; spikelets appressed and clustered along the branches, base of branches naked for 0.3–1 cm, margins scabrous (Fig. 3); lowermost branches longest (2–3.5 cm long), hence inflorescence pyramidal, branches distant, lower two 1–2 cm apart; spikelets 1–3 flowered (if 1-flowered the rachilla prolonged as a minute stipe), plumbeous, lowermost spikelets with one floret (and an aborted floret (fig. 12 and 15) or sometimes only a rachilla joint), those spikelets in center of branch and toward the end with two or three florets, 2–3.5 mm long (average length of 30 spikelets: 3 mm); first glume 1–2.2 mm long (average length of 30 first glumes: 1.4 mm), 1-nerved, thin, plumbeous, scaberulous; second glume 1.2–2.3 mm long (average length of 30 second glumes: 1.7 mm), otherwise like the first glume; lemma of the first floret 2.1–3.3 mm long (average length of 30 lemmas of first florets: 2.8 mm), 3-nerved, lateral nerves indistinct, scabrous on the keel and scaberulous over the back, sparingly pilose on the margins (margins of the lemma of the first floret more pilose than the margins of lemmas of the second and third florets); palea about 1 mm shorter than the lemma, 2-keeled, scabrous on the keels toward the tip, in mature spikelets clasping the caryopsis and standing out prominently from the lemma (Fig. 12); lodicules 2, 0.5–0.8 mm long (Fig. 12); stamens 3 (Fig. 13), about 1.5 mm long (measurements made on stamens of the first floret); styles relatively thick, short, separate at top of ovary; stigmas 2, plumose and curly (Fig. 14), exserted laterally during anthesis; caryopsis light brown, 1.4 mm long, oblong (Fig. 16).

Summary.—*Chaboissaea ligulata* Fourn., a little known grass from Mexico, is redescribed and illustrated. The species was described from material collected in San Luis Potosí in 1851, precise locality not given. It is represented by a single collection from Sanchez, Chihuahua (1910) and by three collections from San Felipe, Guanajuato (1952). The grass belongs in the tribe Festuceae. Significant additions to the original description are the following: Perennial; spikelets 1–3 flowered; glumes 1-nerved; lemmas 3-nerved, and florets with 2 lodicules.

LITERATURE CITED

Bews, J. W. *The world's grasses:* 205. London, 1929.

Conzatti, C. *Flora taxonomica Mexicana* **1:** 254. 1946.

Fournier, E. *Mexicanas plantas*, pt. 2: 112. Ex Typographeo Republicae, Parisiis, 1886.

Hackel, E. *The true grasses:* 211. [Translated from *Die natürlichen Pflanzenfamilien* by F. Lamson-Scribner and E. A. Southworth.] New York, 1890.

Hitchcock, A. S. *Mexican grasses in the United States National Herbarium.* Contr. U. S. Nat. Herb. **17:** 291. 1913.

Lamson-Scribner, F., and Merrill, E. D. *Studies on American grasses. I. Some recent collections of Mexican grasses.* U. S. Dept. Agr. Div. Agrost. Bull. **24:** 19–20. 1900.

ZOOLOGY.—Thysanopoda spinicaudata, *a new bathypelagic giant euphausiid crustacean, with comparative notes on* T. cornuta *and* T. egregia. EDWARD BRINTON, Scripps Institution of Oceanography,[1] La Jolla, Calif. (Communicated by Fenner A. Chace, Jr.)

The bathypelagic giant euphausiids are taken here to include Crustacea belonging to the order Euphausiacea which live planktonically at great depths in the ocean, commonly below 2,000 meters. These giants among euphausiids are little known, probably owing to the fact that they are not abundant and live below the range of sampling of ordinary plankton-collecting gear. It is also possible that they are fast swimmers and are able to escape most nets. Together with *Thysanopoda spinicaudata*, n. sp., described below, the group includes at present only *Thysanopoda cornuta* Illig, 1905, and *T. egregia* Hansen, 1905. These euphausiids comprise a subdivision, "Group B," of the genus *Thysanopoda*, which was observed by H. J. Hansen (1912) to constitute a morphologically related unit. Four characters define this unit: a well-developed cervical groove separates the head area of the carapace from the thoracic region; the pseudoexopod of the first maxilla scarcely overreaches the outer margin of the joint, or does not overreach it at all; the endopod of the first maxilla is very long; the sixth abdominal somite is shorter than the fifth.

Euphausiids of this group are readily distinguished from other euphausiids, especially by means of the short sixth abdominal somite. Among the other species of Euphausiacea, only *Thysanopoda cristata* G. O. Sars, a midwater form which appears to be closely related to the giant euphausiids, possesses a sixth abdominal somite which is nearly as short as the fifth.

The euphausiids which live above a depth of about 500 meters are relatively small in size, reaching a maximum length of about 20 mm. There are two exceptions: the Antarctic *Euphausia superba* Dana which sometimes attains a length of 60 mm, and *Meganyctiphanes norvegica* (M. Sars) of the North Atlantic which reaches 40 mm. The euphausiids of the upper strata include numerous species belonging to nine genera, including one species *T. aequalis* Hansen, of Hansen's "Group A" of *Thysanopoda*.

The population which normally inhabits waters between about 500 and 2,000 meters is characterized by fewer genera and species, and by somewhat larger euphausiids. The largest of these, which sometimes attain a length of 50 mm, are *Thysanopoda acutifrons* Holt and Tattersall, and *T. cristata* G. O. Sars, both of which belong to Group A of *Thysanopoda*, and the monospecific *Bentheuphausia amblyops* (G. O. Sars).

The typical euphausiids below 2,000 meters are the bathypelagic giant euphausiids which belong to Group B of *Thysanopoda*. *Bentheuphausia*, and some other species whose major concentration is in upper layers, may, however, be present in this deep zone from time to time. The largest specimen in the Scripps Institution collections of the bathypelagic giant *T. egregia* is an adult female 62 mm long; the female specimen of *T. spinicaudata* measures 84 mm, and the largest known specimen of *T. cornuta*, a male collected by the Scripps Institution vessel *Horizon* in the southeastern Gulf of Alaska, is 95 mm long. These euphausiids not only attain a somewhat greater length than the Antarctic surface form *Euphausia superba*, but are also more broad. It is of interest to note, however, that both *E. superba* and the bathypelagic giant euphausiids inhabit waters which are colder than 2–3°C.

It has been necessary to describe *T. spinicaudata* from a single specimen. This is felt to be justified in view of the extreme scarcity of animals of this group. *T. egregia* Hansen (1905), was described from a single specimen captured near the insular slope of the Madeira Islands, while *T. cornuta* Illig (1905), was described from one animal from the Wallfisch Ridge of the Southeastern Atlantic. Illig (1905, 1930) and Hansen (1905, 1915) figure some of the features of *T. cornuta*, while Hansen (1905) has drawn the anterior part of *T. egregia*.

I am indebted to Prof. Martin W. John-

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[1] Contributions from Scripps Institution of Oceanography, new ser., no. 652.

son, under whose supervision a study of the Pacific euphausiids is being carried out, for his criticism and suggestions.

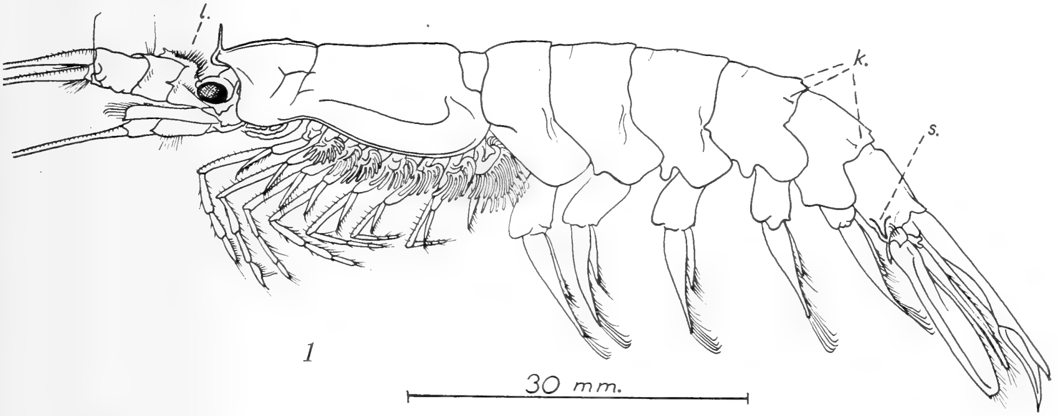
Thysanopoda spinicaudata, n. sp.

Figs. 1, 3, 6, 10, 11

Holotype.—Female; length 84 mm.

Diagnosis.—The carapace is without lateral denticles in the adult. A cervical groove crosses the dorsal part of the carapace. Lateral furrows (Fig. 1) are continuous with the cervical groove A longitudinal submarginal ridge extends along the lateral margin of the carapace posterior to the subvertical grooves. The lateral limits of the carapace are thickened to form marginal ridges. Viewed dorsally (Fig. 3), the anterior margin of the carapace is slightly convex. The dorsal anterior end of the frontal plate is armed with a strong vertical spine 1.4 mm in length. A low middorsal keel is present on the carapace, extending from the vertical spine to the cervical groove. The keel is interrupted near its midpoint by a short, obtuse prominence. Viewed laterally, the thickness of the frontal plate is less than the length of the dorsal spine. The anterior margins of the frontal plate, lateral to the spine, are slightly upturned.

The proximal end of the lower flagellum of the first antenna carries a dense tuft of long, colorless setae. The heavily setose, raised dorsal area of the first article of the peduncle of the first antenna (Fig. 1, 3) is equipped terminally with an acute tooth which is bulbous at its base and which is directed upward and laterally. The setose



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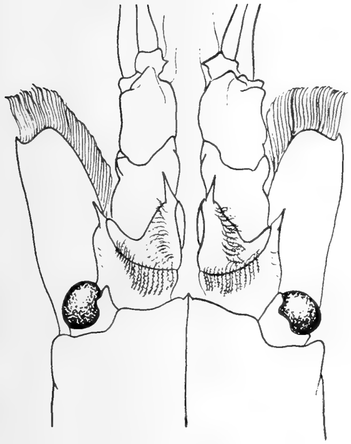

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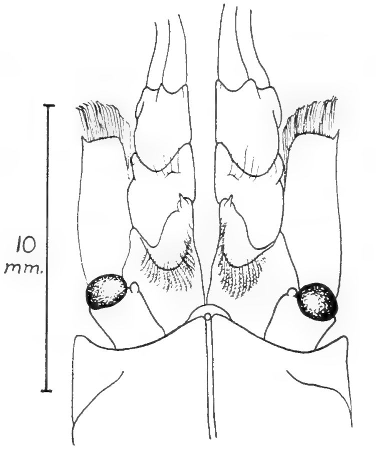

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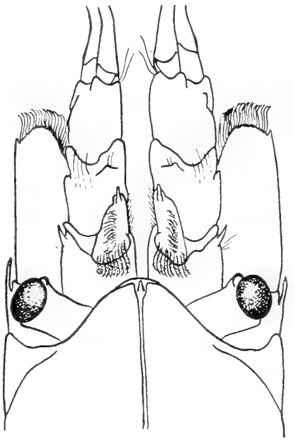

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FIGS. 1–4.—1, *Thysanopoda spinicaudata*, adult female: *k*, Keels on fourth and fifth abdominal somites; *l*, lappet on first article of antennular peduncle; *s*, spine on sixth abdominal somite. 2, *T. egregia*, anterior region, dorsal view. 3, *T. spinicaudata*, anterior region, dorsal view. 4, *T. cornuta*, anterior region, dorsal view.

part of the lappet of the first article is not produced posteriorly beyond its point of junction with the main part of the article; hence it does not overhang the trunk of the article. The scale of the second antenna is truncated distally (Fig. 3). A denticle is present at the antero-lateral angle.

T. spinicaudata derives its name from a heavy spine which is directed posteriorly and laterally from each side of the sixth abdominal somite (Fig. 1, s.). This spine orginates a short distance forward of the posterior margin of the somite and, together with that part of the pleuron adjacent to it, is situated so as to serve as a protective socket for the articulated base of the uropod.

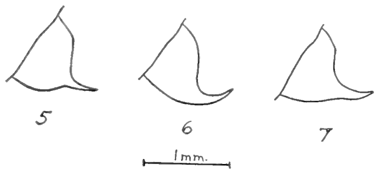
The pleura of the second abdominal segment are very slightly produced at the anterolateral angle, while those of the third and fourth segments are distinctly lobed. The pre-anal spine curves upward distally. Viewed laterally (Fig. 6), its lower margin traces a simple arc from the base of the spine to the acute tip.

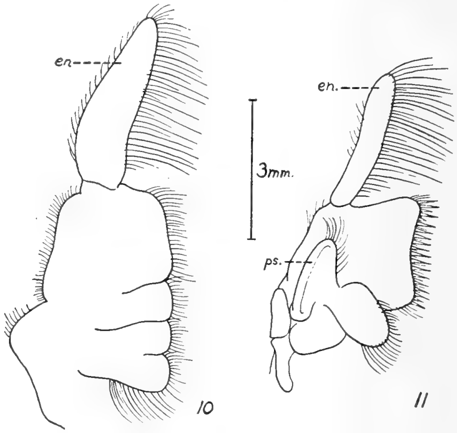
The endopod of the first maxilla (Fig. 11) is slightly convex in outline along its inner longitudinal border and concave on its outer margin. The pseudoexopod of the first maxilla bears no indentation on its slightly thickened outer margin. The endopod of the second maxilla is very elongate (Fig. 10). The terminology for the mouthparts is that employed by Hansen (1925).

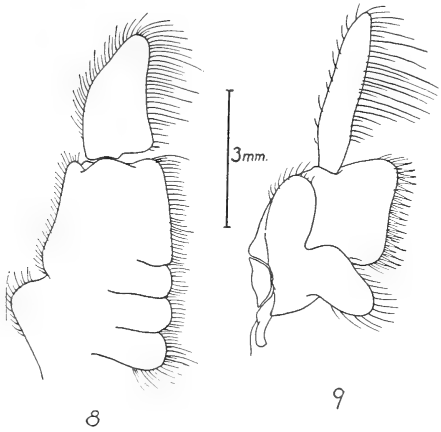
T. spinicaudata is brilliant red in color except for black eyes; white, richly arborescent gills, and tufts of fine, colorless setae at the bases of the outer flagella.

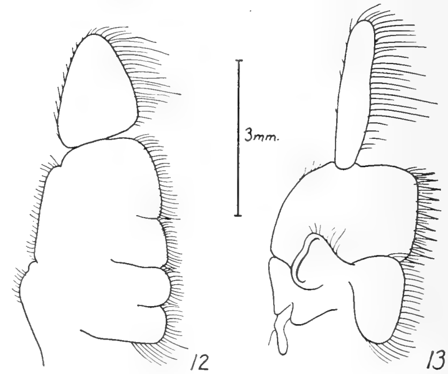
Type specimen.—The type specimen is deposited in the U. S. National Museum, no. 95677.

Remarks.—The frontal plate of this proposed new species is not produced anteriorly to the extent that it is in *T. cornuta* (Fig. 4), nor is it so obtuse, when viewed dorsally, as in *T. egregia*.









FIGS. 5–13.—5, *Thysanopoda cornuta*, pre-anal spine. 6, *T. spinicaudata*, pre-anal spine. 7, *T. egregia*, pre-anal spine. 8, *T. cornuta*, left second maxilla. 9, *T. cornuta*, left first maxilla. 10, *T. spinicaudata*, left second maxilla. *en.*, endopod. 11, *T. spinicaudata*, left first maxilla; *en.*, endopod; *ps*, pseudoexopod. 12, *T. egregia*, left second maxilla. 13, *T. egregia*, left first maxilla.

A small tubercle, comparable to but much smaller than the dorsal spine of *T. spinicaudata*, is present on the frontal plate of *T. cornuta*. Seen laterally, the thickness of the frontal plate of *T. cornuta* is much greater than the length of the tubercle. The frontal plate of *T. egregia* is curved downward. The middorsal keel on the carapace of *T. cornuta*, anterior to the cervical groove, is higher and more massive than in *T. spinicaudata*, while in *T. egregia* it is lower, broader, and poorly defined.

The proximal end of the lower flagellum of the first antenna of the males of *T. cornuta* and *T. egregia* is much thicker than that of the females of these two species and of *T. spinicaudata*. However, in each of the species the end carries a tuft of long setae which is more dense in males of *T. cornuta* and *T. egregia* than in females.

In *T. cornuta* and *T. egregia* the setose lappet of the first article of the peduncle of the first antenna is produced posteriorly, and slightly overhangs the trunk of the article. In the same two species, the distal margin of the scale of the second antenna is convex, when viewed dorsally (Figs. 2, 4), while in *T. spinicaudata* it is obtuse or truncated.

The fourth and fifth abdominal somites in all three species each bear three abbreviated keels: a mid-dorsal keel, flanked by a pair of subdorsal keels (Fig. 1). The posterior dorsal surface of the sixth somite is hollowed, forming a dorsolateral ridge along each side of the posterior half of the somite.

The ventral margins of the pre-anal spines of *T. egregia* and *T. cornuta* are indented (Figs. 5, 7), while in *T. spinicaudata* this margin is convex. The spines in the two former species show no sexual dimorphism.

Distinctions between these allied species are found also in details of mouthpart structure. The pseudoexopod of the first maxilla of *T. egregia* (Fig. 13) is, as in *T. spinicaudata*, slightly thickened along its outer margin. It is also indented near the midpoint of that margin, while the same margin of the pseudoexopod of *T. spinicaudata* is entirely convex. The pseudoexopod of the first maxilla of *T. cornuta* (Fig. 9) is flat and reaches to the outer margin of its joints.

The endopod of the second maxilla of *T. egregia* (Fig. 12) and of *T. cornuta* (Fig. 8) is half again as long as it is wide. The entire margin is convex in outline in *T. egregia*, while the inner margin of the same endopod of *T. cornuta* is concave in profile.

Larvae tentatively assigned to *T. cornuta* by Illig (1930) and Zimmer (1914) possess spiniform processes at the subdorsal posterior margins of the sixth abdominal somites. Compared with the latero-ventral spines which are subterminal to the sixth segment of *T. spinicaudata*, these are dorsolaterally situated and are present only in the larval (furcilia) stages of *T. cornuta*. The Scripps collections contain a series of the larvae which have the spiniform processes. Observations upon the development of the lateral groove complex on the carapace and of the tubercle on the frontal plate of the carapace indicate that these larvae belong to *T. cornuta*.

Type locality and collecting gear.—*T. spinicaudata* was collected by use of the Isaacs-Kidd Midwater Trawl at 2,200 meters in 4,070 meters of water, between 25°52′N, 114°40′W, and 26°00′N, 114°24′W. This is 75 miles west of the Baja California continental slope, adjacent to the southern shoulder of Rosa Bank.

Distribution.—*T. cornuta* and *T. egregia* have been taken at depths of 1,100–6,000 meters in the Atlantic, Pacific, and Indian Oceans. Larvae are known from 150–1,500 meters. *T. spinicaudata*, taken at 2,200 meters, probably has ecological requirements similar to those of the other two species. Extensive sampling in the Northeastern Pacific by Scripps Institution vessels indicates that the giant forms occur in deep waters seaward of continental shelves and borderland areas.

REFERENCES

Hansen, H. J. *Preliminary report on the Schizopoda collected by H. S. H. Prince Albert of Monaco during the cruise of the* Princesse-Alice *in the year 1904.* Bull. Inst. Oceanogr. Monaco, no. 30: 32 pp., 24 figs. 1905.

———. *The Schizopoda. Reports on the scientific results of the expedition to the tropical Pacific, in charge of Alex. Agassiz, by the U. S. Fish Commission steamer* Albatross . . . Mem. Mus. Comp. Zoöl. **35:** 173–296, pls. 1–12. 1912.

———. *Studies on Arthropoda II (Crustacea):* 1–176, 8 pls. Copenhagen, 1925.

Illig, G. *Eine neue Art der Gattung* Thysanopoda. Zool. Anz. **28:** 663–664, 3 figs. 1905.

———. *Die Schizopoden der Deutschen Tiefsee-Expedition.* Deutsche Tiefsee Expedition, 1898–99, **22**(6): 379–625, 215 figs. 1930.

Tattersall, W. M. *Crustaceans of the orders Eu-*

phausiacea and Mysidacea from the Western Atlantic. Proc. U. S. Nat. Mus., **69**(8): 1–31, pls. 1–2. 1926.

———. *The Euphausiacea and Mysidacea of the John Murray Expedition to the Indian Ocean.* The John Murray Expedition, 1933–34, Scientific Reports **5**(8): 203–246, 21 figs. 1939.

Zimmer, C. *Die Schizopoden der Deutschen Südpolar Expedition, 1901–1903.* Deutsche Südpolar-Expedition **15**(4): 377–445, 4 pls. 1914.

ZOOLOGY.—*On the ranges of certain crayfishes of the* Spiculifer *group of the genus* Procambarus, *with the description of a new species*[1] (Decapoda: Astacidae).

Horton H. Hobbs, Jr., University of Virginia. (Communicated by Fenner A. Chace, Jr.)

Six species of crayfishes belonging to the Spiculifer group of the genus *Procambarus* are known to inhabit lotic situations in Alabama, Florida, Georgia, and South Carolina. Of these, three have been described: *P. spiculifer* (LeConte, 1856:401), *P. versutus* (Hagen, 1870:51), and *P. suttkusi* Hobbs (1953:173). A description of the fourth is given below; however, before those of the other two are made larger series of both are needed.

Plotted on the accompanying map are the locality records available for the four described species. Since *P. spiculifer* and *P. versutus* are known from so many localities, a listing of the localities from which they have been collected seems superfluous; however, exact locality data have been given for *P. suttkusi* and are listed for the species described below.

The greatest gap in our knowledge lies in the region of the middle Chattahoochee and in the Alabama River system. It will be noted from map 1 that *P. spiculifer* is known from headwater streams of the Alabama River in Georgia as well as from localities near its mouth, but whether it occurs in the region between is not known. Specimens of *P. spiculifer* from over its entire known range have been examined rather carefully, but variations are few, and in no place where adequate series are available do any of these variations seem to be confined to local populations. A study of variations in *P. versutus* has been deferred until more specimens from central Alabama become available.

Genus **Procambarus** Ortmann (1905)

Procambarus raneyi,[2] n. sp.

Diagnosis.—Rostrum with lateral spines and without a median carina; areola relatively broad and short (about four times as long as broad and about 28 per cent of entire length of carapace); two lateral spines on each side of carapace. Male with hooks on ischiopodites of third and fourth pereipods; palm of chela of first form male not bearded but bearing a row of 7 to 9 tubercles along mesial margin. Postorbital ridges terminate cephalad in spines. First pleopod of first form male (Figs. 1 and 3) without a shoulder on cephalic margin and terminating distally in three distinct parts. Mesial process subspiculiform and directed caudodistad; cephalic process absent (as in *P. spiculifer*); caudal element consists of a small corneous curved tooth lying at the caudal base of the central projection; the compound central projection, the most conspicuous of the terminal elements, beaklike, corneous, and with its tip directed caudad; as is usual the centrocephalic process is much larger than the centrocaudal one. Annulus ventralis partially hidden by tuberculate extensions from the sternum anterior to annulus (Fig. 2).

Holotypic male, form I.—Body subovate, somewhat compressed laterally; abdomen slightly shorter than carapace (53.2–55.2 mm). Height and width of carapace in region of caudodorsal margin of cervical groove subequal; greatest width of carapace a little cephalad of caudodorsal margin of cervical groove (25.3 mm).

Areola relatively broad and short, about 4.4

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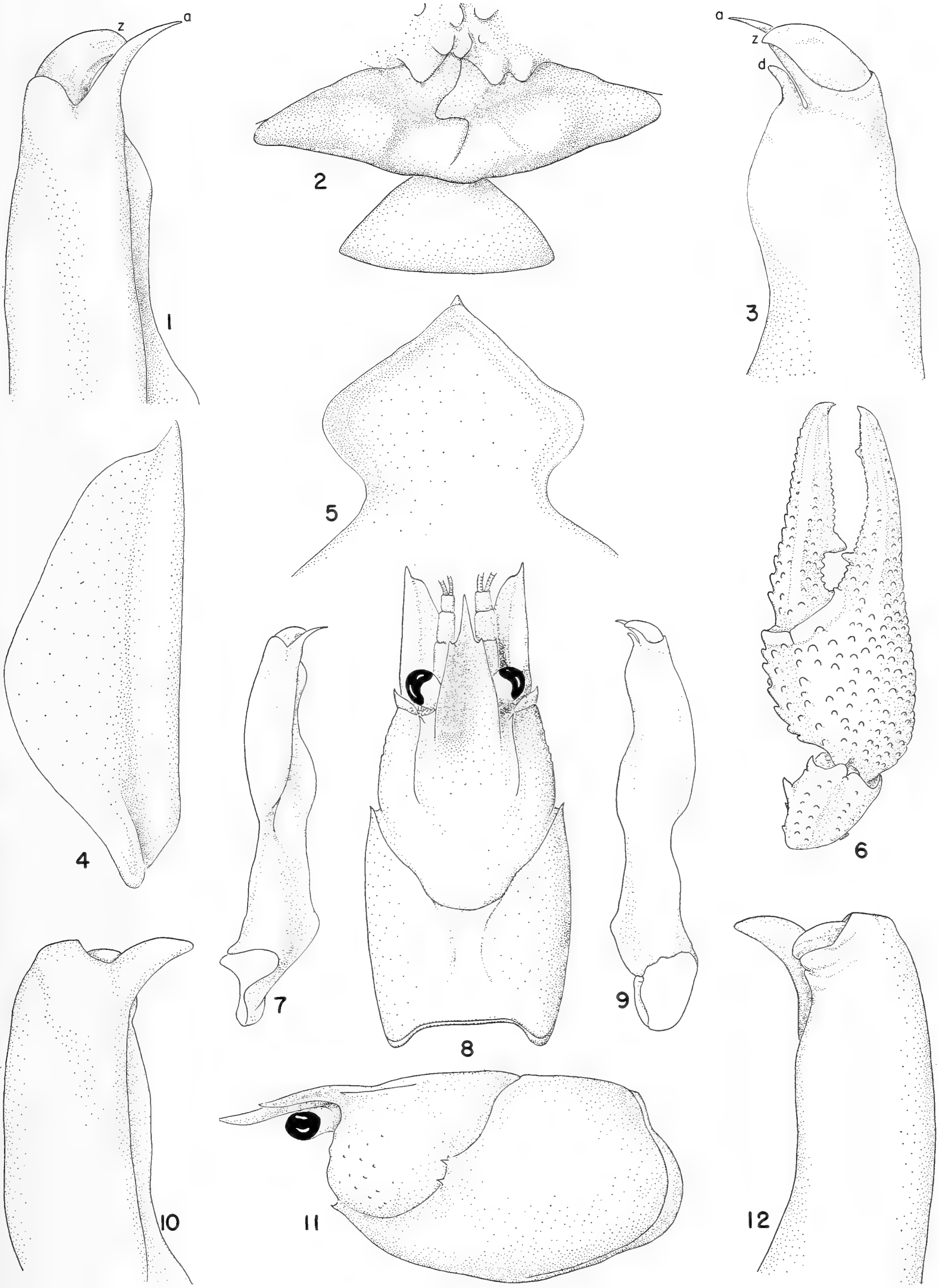
[1] Contribution from the Samuel Miller Biological Laboratories. I wish to thank Dr. E. C. Raney and Dr. D. C. Scott for their kindness in collecting for me the specimens on which this description is based, as well as for those on which many of the locality records indicated on the map are established.

[2] I name this species in honor of my good friend Dr. Edward C. Raney, of Cornell University, who has so graciously donated to me large numbers of crayfishes which he has collected while studying the fishes in the eastern part of the United States. Without his aid our knowledge of the crayfishes of the Atlantic slope would have been considerably hampered.



FIGS. 1–12.—*Procambarus raneyi*, n. sp. (Pubescence removed from all structures illustrated): 1, Mesial view of distal portion of first pleopod of holotype; 2, annulus ventral of allotype; 3, lateral view of distal portion of first pleopod of holotype; 4, antennal scale of holotype; 5, epistome of holotype; 6, distal three podomeres of cheliped of holotype; 7, mesial view of first pleopod of holotype; 8, dorsal view of carapace of holotype; 9, lateral view of first pleopod of holotype; 10, mesial view of distal portion of first pleopod of morphotype; 11, lateral view of carapace of holotype; 12, lateral view of distal portion of first pleopod of morphotype (*a*—mesial process; *d*—caudal process; *z*—central projection.)

times as long as wide with five or six punctations in narrowest part. Cephalic section of carapace about 2.3 times as long as areola (length of areola about 27.6 percent of entire length of carapace).

Rostrum moderately long, excavate; sides subparallel basally, slightly converging distally to base of long acumen which is set off by acute lateral spines. Acumen longer than half the remainder of rostrum. Margins of rostrum not swollen or conspicuously elevated. Upper surface with a few scattered minute setae. Subrostral ridges poorly developed and not evident in dorsal aspect.

Postorbital ridges prominent, shallowly grooved laterally, and terminating cephalad in acute spines. Suborbital angle weak and obtuse; branchiostegal spine strong. Two strong acute spines present on each side of carapace; upper surface of carapace punctate and lateral surface granulate.

Cephalic section of telson with two spines in each caudolateral corner. Margin of subtriangular epistome plumose with a very small cephalomedian spine (see Fig. 5).

Antennules of the usual form with a strong acute spine present on ventral side of basal segment.

Antennae extend caudad to telson. Antennal scale long; moderately broad; widest near midlength; outer distal margin with a moderately strong spine.

Right chela depressed with the palm inflated in middle; outer margin of hand concave at base of immovable finger. Hand entirely tuberculate. Inner margin of palm with a row of seven tubercles, with one tubercle below this row and a row of four just above it; a very prominent tubercle present on lower surface of palm at base of dactyl. Opposable margin of dactyl with a row of 23 rounded tubercles, the fifth from base largest and forming a distinct emargination; upper surface of dactyl with a low rounded submedian longitudinal ridge flanked on proximal two-thirds by tubercles and distally by setiferous punctations; mesial margin of dactyl with 12 tubercles; lower margin of dactyl similar to upper surface. Immovable finger with opposable margin concave and bearing an upper row of 24 rounded tubercles, sixth from base largest, and a lower row along distal half of 9 tubercles of which the sixth from base is largest; upper and lower surfaces similar to those of dactyl; although less tuberculate, lateral margin of immovable finger with a rounded longitudinal ridge flanked by tubercles proximally and setiferous punctations distally.

Carpus of first right pereiopod longer than broad; upper surface with a deep submedian furrow, flanked mesially by two rows of tubercles and laterally by less well defined rows; submedian furrow interrupted distally by a small tubercle near distal margin of podomere. Mesial surface with row of five tubercles, the third and fifth distinctly larger than others. Lower mesial margin with a row of four tubercles, the distal one of which is largest and corresponds to the mesial member of the usual two tubercles present on distal margin. Between these two rows is a group of four small tubercles. Lower surface with a large distal tubercle and a few scattered small ones. Lateral surface with small squamous tubercles.

Merus of first right pereiopods with small tubercles and scattered punctations on lateral surface; upper surface with tubercles along entire length, except near distal extremity, with two of the more distal ones distinctly larger than the others; mesial surface smooth proximally, with a few tubercles distally, and somewhat excavate along middle three-fourths, producing a longitudinal furrow near lower margin. Lower surface with two rows of spikelike tubercles, an outer one of 15 and an inner one of 15; scattered small tubercles are present between and to the side of these two rows.

Lower surface of ischiopodite bearing a mesial row of five spikelike tubercles and a lateral row of small tubercles; these are continuations of the corresponding rows on merus.

Basipodite and coxopodite with no tubercles.

Hooks present on ischiopodites of third and fourth pereiopods; hooks are both long and slender and only slightly recurved. Basipodite of fourth pereiopod bears no tubercle opposing the hook on ischiopodite; hooks of both third and fourth pereiopods extend proximad of distal end of their respective basipodites. Coxopodites of fourth and fifth pereiopods with caudomesial projections: that on fourth heavy and inflated, and that on fifth somewhat smaller and more sharply defined.

First pleopod extending to coxopodite of third pereiopod when abdomen is flexed. Tip terminating in three distinct parts (Fig. 3). Mesial process spiculiform and gently curved caudodistad; cephalic process represented by a mere rounded lobe at cephalic base of central projection; caudal element consists of a corneous well-defined caudal process and a very small and poorly defined caudal knob; central projection, the most conspicuous of the terminal elements, corneous, broad (cephalocaudal axis), and directed caudolaterad.

Allotypic female.—The allotype differs only in a few minor details from the holotype; opposable margin of dactyl of right chela with 14 tubercles; opposable margin of immovable finger of chela with upper row of 10 tubercles and no lower row; inner surface of carpus of left chela with three major tubercles instead of two; two rows of tubercles on lower surface of merus with fewer tubercles than in holotype. See measurements for differences in proportions.

Annulus ventralis only slightly obscured in ventral aspect by small tubercles extending caudally from sternum immediately cephalad of annulus. Annulus subovate with the greatest length in the transverse axis; a transverse depression near midlength with high wall cephalad cut by a troughlike depression; caudomesial portion with a raised (ventrally) prominence. Sinus originates along median line near cephalic margin of annulus, extends caudodextrad and turns sharply sinistrad to cross the median line, and from there curving gently caudad to the midcaudal margin of the annulus (Fig. 2).

Morphotypic male, form II.—Differs from the holotype in the following respects: Abdomen slightly longer than carapace (52.8–50.8 mm); inner margins of palm of right chela with a row of three tubercles above the main row and only one below it; opposable margin of dactyl with a row of 18 tubercles, the fourth from base largest; opposable margin of immovable finger with upper row of 16 tubercles, fourth from base largest, and lower row of four. Lower surface of merus with mesial row of 14 tubercles and a very irregular lateral row. Hooks on ischiopodites of third and fourth pereiopods much reduced and neither extends proximad of basipodite of respective appendage. Prominences on coxopodites of fourth and fifth pereiopods much reduced.

First pleopod with three terminal elements visible (Figs. 10 and 12); the conspicuous mesial process directed caudally as are the less prominent caudal process and central projection.

Measurements.—As follows (in mm):

	Holotype	Allotype	Morphotype
Carapace:			
Height	25.2	23.1	24.0
Width	25.3	22.9	24.4
Length	55.4	47.1	51.0
Areola:			
Length	15.3	13.4	14.3
Width	3.7	3.7	4.0
Rostrum:			
Length	18.2	14.6	15.8
Width	8.5	7.6	8.2
Right chela:			
Length of inner margin of palm	19.4	10.1	13.5
Width of palm	20.5	12.2	13.8
Length of outer margin of hand	51.5	28.8	22.2
Length of dactyl	31.8	16.9	38.3

Type locality.—South fork of the Broad River, 1 mile south of Carlton on the Oglethorpe–Madison County line, Georgia (Savannah River drainage system).

Disposition of types.—The holotypic male, form I, allotypic female, and morphotypic male, form II are deposited in the United States National Museum (nos. 95124, 95125, and 95126, respectively). Of the 39 paratypes, one male, form I, one male, form II, and one female are deposited in the Museum of Comparative Zoology, and a similar series in the collection of Dr. G. H. Penn. One male, form I, is deposited in the United States National Museum and four males, form I, two males, form II, 15 females, 7 juvenile males, and 14 juvenile females are retained in my personal collection at the University of Virginia.

Relationships.—*Procambarus raneyi* has its closest affinities with *P. spiculifer* (LeConte); however, it may be distinguished from the latter by the structure of the first pleopod of the male and the annulus ventralis of the female.

Specimens examined.—All these specimens were collected from streams.

SAVANNAH RIVER DRAINAGE

GEORGIA: *Madison–Oglethorpe* County line—9-1150-1, Anthony Shoals (south fork of Broad River) 1 mile south of Carlton [type locality], 4♂♂I, 1♂II, 7♀♀, 5 juv.♂♂, 11 juv.♀♀, D. C. Scott, coll.; 4-1550-2a, same locality, 2♂♂, D.C.S., coll. *Madison County*—4-1550-la, Small ck., 5 miles east of Carlton, 1♀, D.C.S., coll.; 4-1550-3, Masons Creek, 11 mi. W. of Royston on Route 29, 1♂II, 1♀, D.C.S., coll.; U.S.N.M. no. 93253 (9/10/47), trib. of Broad River, 0.7 miles southwest of Danielsville on Route 29, 1♂I, E. I. Lachner, coll. *Elbert County*—

4-1550-2a, 2.5 miles east of Broad River on Route 77, 2♂♂II, 2♀♀, 1 juv.♂, D.C.S., coll.; 3-2751-5a, Morea Creek, 1.5 miles south of Nuberg on Route 77, 2♀♀, E. C. Raney, coll. *Stephens County*—4-947-2b, north fork Broad River, 3.7 miles west of Toccoa, 1 juv.♂, 1 juv.♀ E.C.R., coll.

SOUTH CAROLINA: *Abbeville County*—3-2751-1b, Calhoun Creek, 7.6 miles east of Calhoun Falls on Route 72, 2♂♂I, 1 juv.♀, E.C.R. coll.; 3-2751-3, same locality, 1♂I, E.C.R., coll.; 3-2751-4, Long Crane Creek, 4.4 miles east of Abbeville, 1♀, E.C.R., coll.; 3-2751-6, Little River, 5.6 miles east of Calhoun Falls on Route 22, 1♂II, 2♀♀, 1 juv.♀, E.C.R., coll.

OCMULGEE RIVER DRAINAGE

GEORGIA: *Dekalb County*—3-2950-2, Flat Shoals on South River near Decatur, 4♂♂I, 4♀♀, E.C.R., coll.

Discussion.—*Procambarus raneyi* inhabits tributaries of the Savannah River in the Piedmont Province in Georgia and South Carolina and is known from a single locality in the headwaters of the Ocmulgee River (Altamaha River drainage) in Dekalb County, Ga. This latter locality, an isolated one, is of considerable interest, for here this species is surrounded by its nearest relative, *P. spiculifer* (see map 1), which is found in the Chattahoochee, lower Ocmulgee, and Oconee drainages. The simplest explanation as to how *P. raneyi* gained entrance into the headwaters of the Ocmulgee would involve transport by human agencies. There seems to be little reason to assume, however, that once introduced into a stream which is largely dominated by *P. spiculifer* it would be able to replace the latter. Certainly from an anatomical standpoint it has no obvious advantageous characteristics, and there are no data available concerning the reproductive capacities of either species. Although there is no geological evidence, nor are there other evidences, to support any other explanation for their presence here, it does not seem amiss to pose the question as to whether or not the Dekalb County population represents a relict fauna.

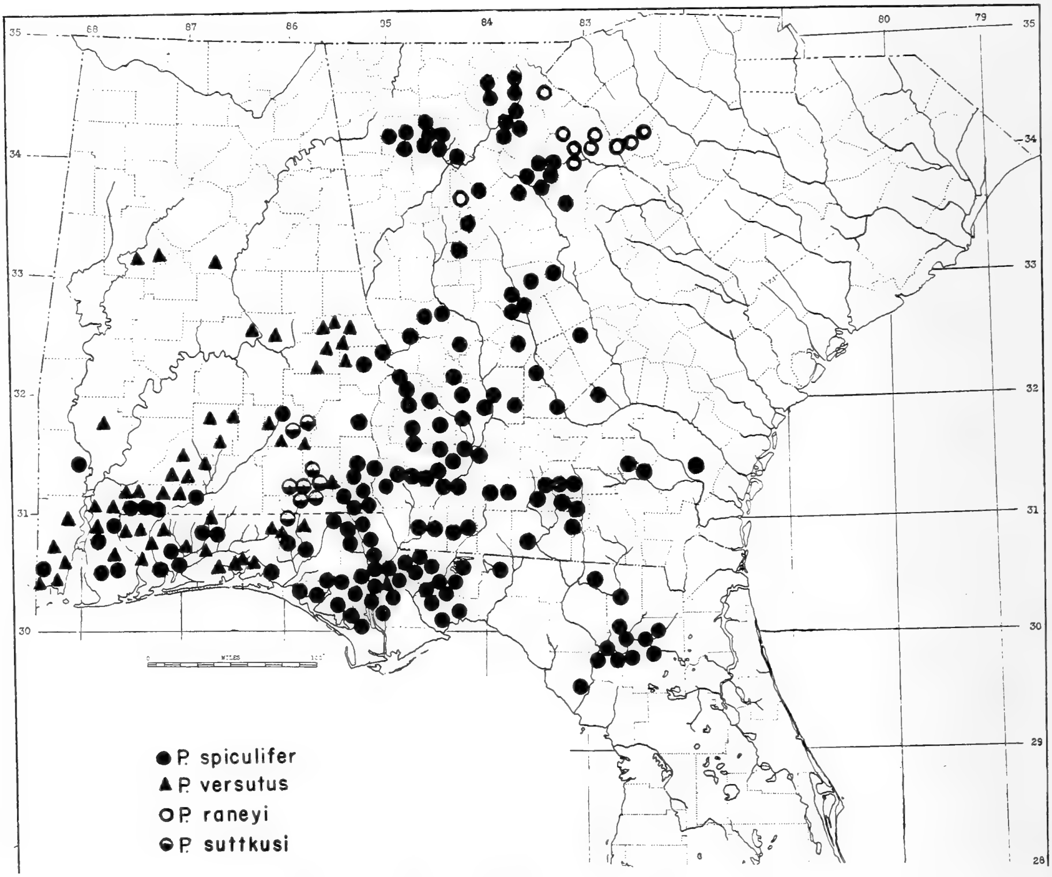


FIG. 13.—Map of locality records for four species of *Procambarus*.

LITERATURE CITED

HAGEN, HERMAN. *Monograph of the North American Astacidae.* Illus. Cat. Mus. Comp. Zool., No. 3; 1–109 pls. 1–11. 1870.

HOBBS, HORTON H., JR. *A new crayfish of the genus* Procambarus *from Alabama and Florida.* Proc. Biol. Soc. Washington **66**: 173–178, 1953.

LECONTE, JOHN. *Description of new species of* Astacus *from Georgia.* Proc. Acad. Nat. Sci. Philadelphia **7**: 400–402. 1856.

ZOOLOGY.—*New millipeds of the western States and Lower California.* H. F. LOOMIS, Coconut Grove, Fla.

For many years past there has been accumulating a number of interesting but undescribed millipeds in the writer's collection. These have not lent themselves to inclusion in systematic treatment of groups that have been prepared recently or are contemplated. Several of the species exhibit characters that affect the present concepts of the family or genus to which they belong and consequently are especially noteworthy. Types of species here described are deposited in the U. S. National Museum.

Cambala caeca, n. sp.

One broken male (type) from "inner area of bat cave," Wyatt Cave, and 12 females from Felton Cave taken "in association with bat guano" by O. G. Babcock, Sonora, Tex., 1922–23. U.S.N.M. no. 2087.

Diagnosis.—Although departing in several particulars, such as lack of eyes, the anterior segments forming a necklike constriction, and the presence of claws on the first male legs, from the characters associated with the genus, the gonopods are so definitely typical of *Cambala* as to require inclusion of the species there and cause modification of the generic concept involving the above characters.

Description.—Length 22 to 25 mm. Number of segments of females 46 to 48, male type with 54.

Head without eyes, smooth, the clypeus with 6 to 8 setae, the labrum with 12 to 14 setae; antennae with joint 2 longest, joint 6 broadest and next in length.

First segment as long as the next three together, anterior angle broadly rounded and flaring outward somewhat from the side of the head; posterior angle slightly produced backward; surface of segment smooth but with a fine raised rim along the lateral margin. Fig. 1.

Segments 2 and 3 with sides converging backward to form a noticeable necklike constriction; segment 2 entirely smooth above with segment 3 usually so, but infrequently dorsal crests are faintly evident near the back margin.

From segment 4 to the penultimate segment inclusive there are four strong, smooth, dorsal crests between the poriferous ones, the latter having the posterior half of the same thickness as the dorsal crests but the anterior half is two or three times as broad, slightly more elevated, and with the pore in the center. Sides of segments striate but the surface just below the upper stria elevated to form a noticeable ridge; prozonites crossed lengthwise by numerous thin, low, beaded ridges.

Last segment smooth, as long as the two preceding segments together.

Anal valves smooth, meeting in a groove. Preanal scale broad, slightly thickened and emarginate at middle and with an erect seta on either side; tab processes large, each with a single seta.

Gonopods as shown in Figs. 2 and 3.

First male legs 6-jointed, the first and second joints short but twice the width of the following joint; last joint not modified and with a normal claw. Legs 6 and 7 with joints 4 and 5 enlarged, the former with a large rounded lobe ventrally.

Remarks.—In Ent. News **63**: 10–11. 1952. Chamberlin described a new genus and species of cambalid from the same two caves and taken by the same collector as were the specimens above referred to the genus *Cambala.* In comparing the specimens before me with Chamberlin's generic and specific descriptions of *Eclomus* (*Eclytus*) *speobius* one is struck by the numerous points of similarity of the two species. *E. speobius*, however, is said to have dorsal carinae somewhat developed on segment 2 and on the succeeding segments "sharply elevated and complete", whereas specimens of *C. caeca* show segment 2 with no semblance of dorsal carinae and in only a few specimens do they appear as faint elevations near the posterior border of segment 3.

In other particulars the similarity is remarkably close but *E. speobius* is credited with but 41–43 segments whereas mature specimens of the present species have 46–54. Since no male characters whatever were mentioned for *E. speobius* it may be inferred that the genus was founded on females, immature specimens or both. With the numerous specimens in both collections coming from the same very restricted locations it is most remarkable that in neither were both species represented. Should it be shown at a later date that but a single species is involved the rules of priority would require that *Eclomus* be placed as a synonym of *Cambala* and *caeca* would then become a synonym of *speobia*.

Orthoporus arizonicus, n. sp.

Two males, 1 the type, and a female collected at Patagonia, Ariz., in July 1949, by R. H. Peebles and sent to me alive. U.S.N.M. no. 2088.

Diagnosis. Closely related to *punctiliger* Chamberlin as indicated by the gonopods but the size is smaller, and more slender; the sculpturing of the segments, anal valves and preanal scale is simply punctate without rugae; and the first segment has but two lateral striae.

Description.—Length 85 to 88 mm, diameter 5 to 6 mm, number of segments 63 to 65. Living color cinnamon brown, with the posterior margin of the segments narrowly darker, legs and antennae also cinnamon brown.

Head with finely impressed sulcus on vertex; front coarsely, longitudinally rugose-punctate below but lessening above; clypeal fovoea 13 or 14; eyes separated by over one and a half times the length of an eye, composed of 53 to 56 ocelli in 7 transverse rows.

First segment (Fig. 4) with two prominent lateral striae only; anterior corner somewhat produced in the male.

All segments, as well as the anal valves and preannal scale, very finely punctate and without any impressed lines or rugosity; transverse sulcus strongly evident throughout, bowed forward around the pore which is a third of the way to the posterior margin; last segment rather acute at tip, considerably exceeded by the anal valves.

Gonopods as shown in Fig. 5.

Hiltonius palmaris, n. sp.

Two males, 1 the type, and a female collected by the writer in Palm Canyon, Palm Springs, Calif., December 4, 1919. U.S.N.M. no. 2089.

Diagnosis.—Apparently most closely related to *H. mimus* Chamberlin but with distinct differences in all parts of the gonopods and in the much larger coxal lobes of the third male legs.

Description.—Length of body 35 to 50 mm, width 4.3 to 6 mm; number of segments 48 to 49.

Head with frontal groove strong and wide, that of the vertex not so pronounced; eyes subtriangular, composed of 25 to 30 ocelli in 6 longitudinal rows; clypeal fovoea 4 to 5 on each side.

Sides of the first, second and third segments as shown in Fig. 6; the anterior margining rim of segment 1 broad; following segments with a fine median sulcus and a sharply marked transverse constriction on either side of which the surface is faintly convex; pore in front of the constriction but not touching it; midbelt with lateral sulcus faint or absent but that of the hindbelt broad and deep in front, diminishing caudally.

Last segment sharply rounded, in one specimen distinctly angulate; transverse impression faint. Anal valves quite evenly inflated, not more conspicuously so near the margins which meet in a shallow groove; surface punctate and with irregular wrinkles near the opening. Preanal scale broadly rounded and with longitudinal striations, more distinct near the hind margin.

Gonopods as shown in Figs. 7 and 8.

Coxae of third male legs as shown in Fig. 9.

Arinolus latus, n. sp.

A number of specimens, including the male type, were collected from beneath stumps of *Yucca arborescens* in Antelope Valley between Lancaster and Palmdale, Calif., January 8, 1928, by O. F. Cook. U.S.N.M. no. 2090.

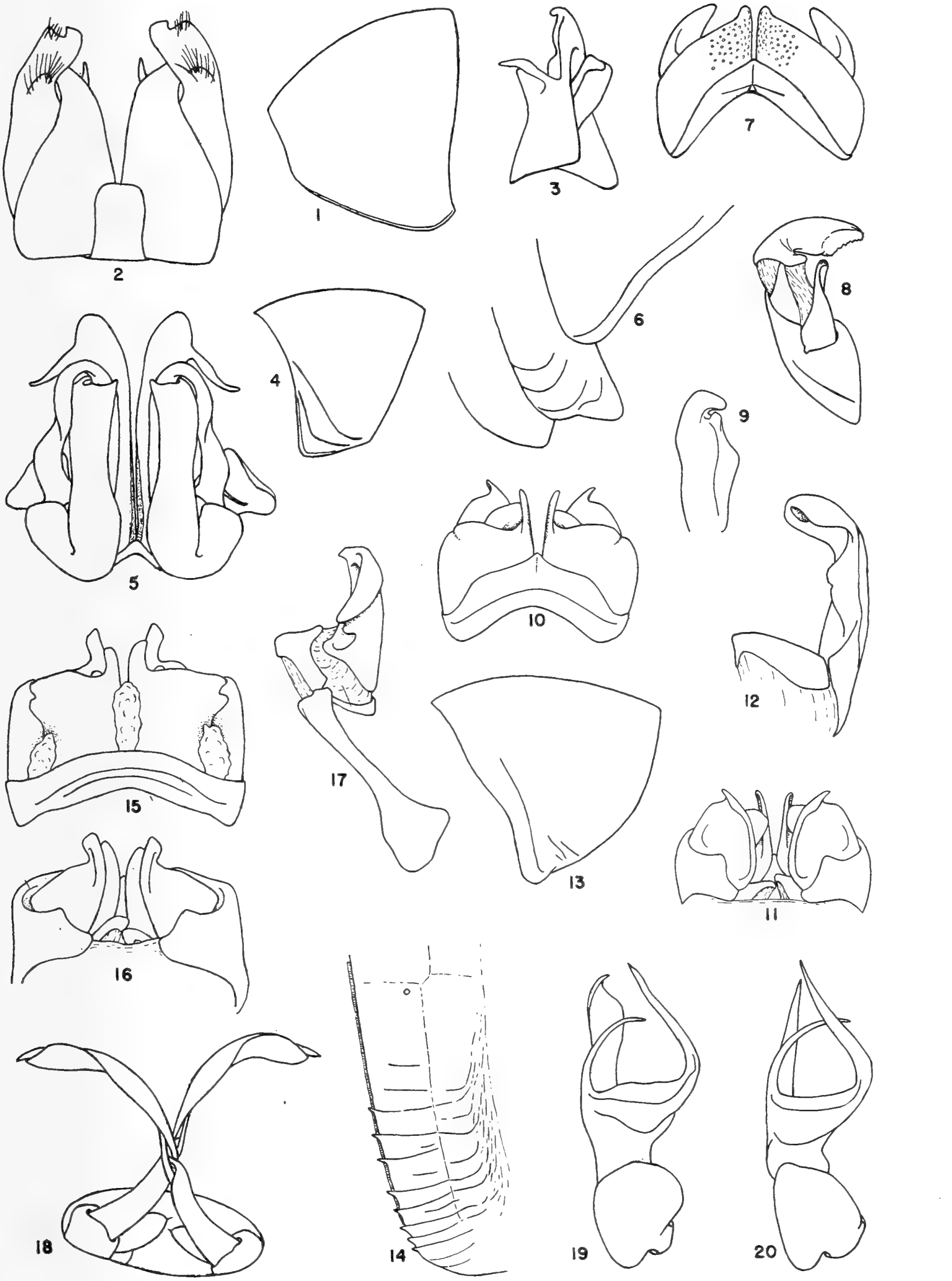
Diagnosis.—Distinguished from the other species by the gonopods, particularly the inner ones, and also by the stout body, thickened posterior margins of the segments, very broadly rounded last segment, and the living color.

Description.—Body very stout and abruptly constricted at the ends; 29 to 35 mm long and 3.5 to 4 mm thick, the females stouter than the males; segments 42 to 44.

Living colors very strongly shining black with the hindbelt almost golden yellow, semi-translucent. In alcohol the hindbelt changes to dull yellow.

Head with a deep median sulcus on the vertex, the surface of which is slightly rugose in contrast to the shining surface elsewhere; clypeus with 5 or 6 punctations each side; eyes inconspicuous, composed of about 24 to 26 low ocelli in 6 rows forming a rounded patch.

First segment with the margin from behind the eye to the lateral angle strongly raised, the angle a little more acute than in *torynophor* Chamb.



FIGS. 1–20.—1, *Cambala caeca*, n. sp., lateral view of first segment; 2, the same, anterior view of gonopods; 3, the same, lateral view of posterior gonopods; 4, *Orthoporus arizonicus*, n. sp., lateral view of first segment; 5, the same, anterior view of gonopods; 6, *Hiltonius palmaris*, n. sp., lateral view of segments 1, 2 and 3; 7, the same, anterior view of gonopods; 8, the same, lateral view of gonopods with inner gonopod extended; 9, the same, coxae of third male leg; 10, 11, *Arinolus latus*, n. sp., anterior and posterior views respectively of gonopods; 12, the same, anterior view of inner gonopod; 13, *Scobinomus serratus*, n. sp., lateral view of first segment; 14, the same, lateral view of lower side of mid- and hindbelt of segment 21; 15, 16, the same, anterior and posterior views respectively of gonopods; 17, the same, inner gonopod; 18, *Chipus unicus*, n. sp., posterior or ventral view of gonopods which are foreshortened in this aspect; 19, *Motyxia expansa*, n. sp., right gonopod; 20, *Motyxia exilis*, n. sp., right gonopod.

and decidedly more so than in *hospes* (Cook) and usually containing one or two rudimentary striae.

Segments with the transverse constriction shallow but evident, the pore located behind it; in lateral view the surface of the segments behind the constrictions is flatter than in the other species but the hind margins are decidedly thicker; lateral sutures usually not visible but occasionally faintly evident behind the pore on segments near the posterior end of the body; median sulcus visible on the posterior third of all segments from the first to the last inclusive, on the latter forming a conspicuous furrow on the apical portion; surface of fore and midbelts as in *torynophor*, the hindbelt punctate but less noticeably striate, except along the thickened hind margin.

Posterior end of body very abruptly constricted, the segments immediately preceding the last strongly telescoped. Last segment short, margin very much thickened, apex subtruncate, very much more broadly rounded than in the other species. Anal valves almost vertical and visible from above, much less inflated than in the other species, and with the margins meeting in a shallow groove. Preanal scale broadly truncate at the apex, the lateral margins noticeably emarginate.

Gonopods as shown in Figs. 10 to 12.

Segment 6 of the males conspicuously wider and longer than the adjacent segments and also wider than segment 1.

Males with coxae of legs 3 and 4 less produced than are those of 5, 6, or 7, which are much as in *hospes* but thicker.

Scobinomus, n. gen.

Genotype: *Scobinomus serratus*, n. sp.

Diagnosis.—Scobinae have been associated with many of the tropical rhinocricids but with none of the North American *Atopetholidae*. The presence of scobinae, though rudimentary, and emargination of the segments above them, in this genus indicate a distinct gap between it and all other known genera of the family. The gonopods bear some resemblance to those of *Tarascolus* Chamb. but the anteriorly exposed coxal joints of the posterior lobes and differently shaped inner gonopods are distinctive characters in addition to the external ones.

Description.—Body rather small and slender, from 10 to 12 times as long as broad; subclavate, the first four or five segments broader than the others.

First segment with the lateral angles narrowed and flaring away from the body, forming its widest part, and distinctly visible from above.

Second segment slightly narrower than the first segment and without an anterior ventral production. Segments 3, 4, and 5 gradually narrowing, after which the segments remain of uniform width to the posterior end of the body except that in the males segment 6 is expanded and nearly as wide as segment 2.

Midbody segments with a strong constriction through the midbelt, the surface behind it conspicuously convex; pore located nearly half way between the constriction and the back margin, immediately behind the suture separating the mid- and hindbelt, thus placing the pore in the latter. Scobinae present, represented by transversely striate areas usually apparent as far forward as segment 6; segments in the scobinate region of the body with the posterior border emarginate adjacent to each scobina of the ensuing segment. Ventral striations reaching about half way to the pore, the marginal angle below each striation carried back into a slender, acute tooth.

Last segment of normal length, the apex broadly rounded and not carried beyond the strongly convex anal valves.

Gonopods with ventral plate short, transverse, not produced at middle; coxal joints of posterior lobes extensively exposed on either side in front; inner gonopods with apical joint short and stout.

Legs long and slender, surpassing the sides of the body. Males with the first two pairs enlarged, the claws double the thickness and length of those on the other legs; coxae of third legs greatly elevated and with the apex bent backward; coxae of ensuing pregenital legs somewhat elevated but not reflexed.

Scobinomus serratus, n. sp.

Male type and three other specimens from 14 miles north of Ensenada, Lower California, January 7, 1925, and three specimens from Ceregas Canyon, 8 to 10 miles from Ensenada, January 5, 1925; collected by O. F. Cook. U.S.N.M. no. 2091.

Description.—Length 30 to 35 mm, width 2.5 to 2.8 mm; number of segments 42 to 46; males more slender than females.

Head with antennae quite slender, joint 2 slightly longest, joints 3 and 6 subequal and next in length, joint 1 slightly longer than joint 7; ocelli 30 to 33 in six series forming a circular cluster; median furrow very faint on the vertex but strongly impressed on the clypeus.

First segment (Fig. 13) emarginate below the eye and with a broad thickened rim; lateral angles narrowly produced downward and flaring outward from the body and forming its widest part, the angles visible from above; surface of the angulation, behind the anterior rim, with 2 to 5 short striae reaching forward from the posterior margin.

Body not shining but with a dull sheen caused by minute reticulation of the entire dorsal surface; in addition there are a few fine punctations more apparent on the anterior end of the body and on the last segment; forebelt of all segments finely transversely striate; midbelt containing a broad transverse constriction that is lacking on the posterior segments; pore located in the anterior portion of the hindbelt which is strongly convex on constricted segments; scobinae, represented by large, triangular, transversely striate areas, as broad as long and lacking an anterior pit, are present from segment 6 or 7 to just beyond the middle of the body, the posterior margin of the segments in the scobinate region emarginate above each scobina of the succeeding segment; ventral striations reaching only halfway to the pores, the posterior marginal angle below each stria produced as a rather long slender tooth, these teeth present on all but four or five segments at each end of body (Fig. 14).

Penultimate segment almost entirely telescoped within the preceding segment, the last segment not telescoped, the apex produced and very broadly rounded but not exceeding the strongly convex anal valves which meet in a deep groove.

Gonopods as shown in Figs. 15 and 16, with a large soft, and fleshy mass above the middle of the ventral plate between the anterior lobes and with a similar fleshy mass on either side at the basal junction of the anterior lobe and the coxal joint of the posterior lobe. Anterior lobes subquadrate, strongly produced at the inner distal corner, each lobe enclosed on the outer side by the conspicuous coxal joint of the posterior lobe, outer joint of the latter rather small, subtriangular, with the apex produced. Inner gonopods as in Fig. 17, the outer joint short, stout, and excavated on the inner side.

Chipus, n. gen.

Genotype: *Chipus unicus,* n. sp.

Diagnosis.—Immediately distinguished from all other members of the family Chelodesmidae by the curious elongated and crossed gonopods which clasp the sides of the body.

Description.—Body strongly convex with lateral carinae more strongly projecting in the male; posterior angles rounded-obtuse, not produced backward except on two or three segments preceding the last; carinae of segment 19 greatly reduced in size and thickness and with the slightly produced posterior angles small and acute. Segment 1 with distinct raised margin on the sides in front.

Gonopods unique in that the principal or posterior divisions are long, slender, two-parted and crossing each other, curving forward and upward between legs 5 and 6 and extending halfway up the sides of the body to the lateral carinae.

Coxae of third male legs each with a hispid, tumid prominence on the ventral face.

Chipus unicus, n. sp.

A male (type) and female collected by A. Gibson, July 20, 1949, in forest of western white pine, western fir, larch, cedar, and hemlock on west fork of Emerald Creek, St. Joe National Forest, Idaho. U.S.N.M. no. 2092.

Description.—Length 30 mm, width 5 mm; both sexes strongly convex, the female much more so.

Head with a deep furrow on the vertex extending downward to between the antennae; labrum and clypeus each with a fringe of close spaced setae, those of the clypeus much the longest; side of head above the clypeal fringe with 6 to 8 widely separated setae, a pair between the antennae and a more widely spaced pair on the vertex; antennae slender, not as long as width of the body and with joints 2–6 inclusive subequal in width and length.

First segment with a rather thick, raised margin extending from just below the antennae to the lateral angle on each side.

Lateral carinae of male projecting outward nearly twice as far as those of female; margins of carinae thickened, posterior angles rounded-obtuse and not produced backward except very slightly on segments 17 and 18, the carinae of segment 19 greatly reduced in size, thin, and with the posterior corner on each side small, acute and definitely produced behind the median margin. Pores opening outward from the customary segments.

Gonopods (Fig. 18) with the posterior divisions very long and slender, crossing each other and passing up the sides of the body, between legs 5 and 6, half way to the lateral carinae; outer portion of each division composed of two slender subequal closely applied pieces; anterior division of gonopods small, conical and not projecting beyond the opening in the segment; the margin of the opening through which the gonopods project thinly raised, highest on the sides.

Coxae of third male legs each with a rounded, hispid lobe on the ventral face.

Motyxia expansa, n. sp.

One male (type) and two females collected at "The Grapevine" below Fort Tejon, Calif., February 28, 1929, by O. F. Cook. U.S.N.M. no. 2093.

Diagnosis.—Differing from Chamberlin's *tejona* and *monica* in minor details of the gonopods, and from the latter, at least, in the more restricted carinae of segments 18 and 19.

Description.—Male 25 mm long and 4.5 mm wide, the largest female 27 mm long and 5 mm wide; male almost as convex as females.

Living color in general light salmon which is most intense on the lateral carinae and along the posterior half of the segments; head, antennae, legs and ventral surface uncolored.

Segments 2, 3 and 4 of typical shape but segments 17, 18 and 19 with lateral carinae much less produced than those of *monica*, segment 19 being almost completely hidden within 18 and its posterior angles small, inconspicuous and very widely separated.

Gonopods as shown in Fig. 19, rising from a transversely oval opening having a thick raised rim behind.

Third male legs each with a rounded coxal lobe, higher than broad, at the inner angle; sternum between fourth legs with a pair of broad, low, rounded elevations.

Remarks.—It is obvious that *expansa*, *tejona* and *monica* are very closely related, but if details of the authors' drawings of the gonopods of these species are compared, it will be seen that specific differences exist. Following the description of *tejona* (Proc. Acad. Nat. Sci. Phila., **99:** 25, 1947) Chamberlin listed the other species in the genus but overlooked *monica*. Having done so, it is probable that he did not compare *tejona* with its closest known relative, but he did compare it with the more distantly related *kerna*.

Motyxia exilis, n. sp.

Several males, one the type, and several females collected at Woodford, near Tehachapi, Calif., January 8, 1928, by O. F. Cook. U.S.N.M. no. 2094.

Diagnosis.—The three slender terminal divisions of the gonopods immediately distinguish this species.

Description.—Somewhat more sturdy than *expansa*, a small male being 25 mm long and 5.5 mm wide and the largest specimen, a female, 30 mm long and 7 mm wide, the males obviously less convex than females.

Living color not noted but the alcoholic specimens are light in shade.

Segments 2, 3 and 4 of customary shape. Segments 17, 18 and 19 with posterior angles backwardly produced; those of segment 18 most prominent; those of segment 19 very small and widely separated; posterior angles of these three segments more acute in males than females and moreso than in either *monica* or *expansa*.

Gonopods as shown in Fig. 20. They protrude from an opening extending backward at middle between the coxae of the eighth legs and with the margining rim higher and thinner than in *expansa*, the coxae less widely separated than in that species.

Males with coxae of third legs each with a smaller lower lobe than in *expansa*; sternum between the fourth legs with the two transverse elevations more pronounced than in *expansa*.

HERPETOLOGY.—*A new snake of the genus* Oligodon *from Annam.* ALAN E. LEVITON, Natural History Museum, Stanford University, Calif. (Communicated by Doris M. Cochran.)

Recently Dr. Doris Cochran, of the United States National Museum, submitted the entire collection of the genus *Oligodon* in the Museum to me for study. She called my attention to one specimen from Indo-China that she was unable to identify and presumed to represent a new species. Subsequent study has led to the confirmation of Dr. Cochran's suspicions.

Oligodon annamensis, n. sp.

Holotype.—U.S.N.M. no. 90408, young female, from Blao, Haut Donai, Annam, French Indo-China; collected by E. Poilane, March 11, 1933.

Diagnosis.—The new species of *Oligodon* differs from all previously described forms by a combination of the following characteristics: Maxillary teeth 8, anal shield single, scales in 13 rows, loreal absent, 6 upper labials, 1 postocular, internasals present.

Description.—Rostral well developed, as broad as deep, the portion visible from above less than half its distance to the frontal. Internasals broader than wide, not separated by the rostral; profrontals larger than the internasals, about one and one-third times as broad as wide, in contact with the second upper labial, nasal, and preocular shields; frontal one and one-third times longer than its distance to the snout, somewhat longer than broad, two times as wide as the supraocular, slightly shorter than the parietals; nasal large, partially divided; loreal absent; one preocular and one postocular; temporals 1 + 2. There are six upper labials, the third and fourth enter the eye; the order in decreasing size is 5, 6, 4, 3, 2, 1. Six lower labials, the first four in contact with the anterior genials which are about two times as long as the posterior shields.

Ventrals 170; subcaudals 30; anal single; scales in 13-13-13 rows.

Maxillary teeth 8, the extreme anterior portion of the maxillary bone edentulous. Three well developed palatine teeth present; no pterygoid teeth were observed.

Eye moderate, its diameter equal to twice its distance to the lip; pupil round.

Measurements.—Total length, 249 mm; tail length, 29 mm.

Coloration.—(Specimen preserved in 75 per cent alcohol.) Ground color light brown. On the head there are several areas of white, black-edged blotches; these include an interocular band, a short interparietal bar, and some small areas on the anterior portion of the snout. The rostral is white, strongly spotted by dark flecks as are the white areas of the bars on the head. A white blotch just in front of the eye covers parts of the second and third upper labials; another blotch extends from the fifth and sixth upper labials diagonally forward to the top of the head where it meets with the interocular band just above the eye. Both of these lateral white areas extend onto the lower labials and genials. There is a long oblique stripe on the neck which extends forward and onto the posterior edge of the parietal; this stripe does not meet its fellow on the parietals. The body is transversed by a series of white black-edged bars, some of which are indistinct; this pattern extends onto the tail. Most of the body scales are edged by darker brown and are all peppered by fine dark flecks.

Ventrally the ground color is white; many of the ventrals and subcaudals are either partially or completely covered by dark brown or black quadrangular spots.

Remarks: There are but three species in the genus *Oligodon* with which *annamensis* could be confused, i.e., *ornatus*, *catenata*, and *violaceus pallidocinctus* (= *cinereus*, var. IV of Smith, 1943). It can be distinguished from these three forms as follows: *ornatus–annamensis* has an undivided anal plate and 13 scale rows while *ornatus* has a divided plate and 15 scale rows; *catenata-annamensis* has a single anal plate and a distinct pair of internasal shields while *catenata* has a divided anal plate and lacks internasals; *cinereus*,

FIG. 1.—Holotype of *Oligodon annamensis*, U.S.N.M. no. 90408.
(Photograph by Antenor L. Carvalho)

var. IV—*annamensis* lacks the loreal and has 13 scale rows while *cinereus* has a loreal shield and either 15 or 17 scale rows.

There can be little doubt that *annamensis* represents a "degenerate" species. This is exemplified by the reduction in the number of head shields, i.e., loss of the loreal, fewer upper labials, and low number of scale rows. Since the tendency toward the reduction in numbers of scales is to be found among many species that represent several species groups within the genus *Oligodon*, great care must be exercised in the interpretation of these traits, and any conclusions concerning relationships derived from such data must be accepted on a provisional basis. A thorough study of the structure of the hemipenes, a problem that I am at present working on, seems to offer the only means by which the seemingly complex evolutionary history of the genus will be unscrambled.

Because of the lack of data concerning the structure of the hemipenes to be found in *annamensis*, any statement of relationships must be for the present considered purely speculative. However, from the evidence available it seems most likely that *annamensis* was derived from *cinereus*. The validity of this supposition must be determined in the future when and if additional specimens of this species, particularly males, may be available for examination.

REFERENCES

Bourret, R. *Les serpents de L'Indochine* **2:** Catalogue *systématique descriptif*, 505 pp., 189 figs. Toulouse, 1936.

Leviton, A. E. *Review of the genus* Oligodon. Pts. I and II. (MS.)

Pope, C. H. *The reptiles of China*, lii + 542 pp., 27 pls., figs. American Museum of Natural History, 1935.

Smith, M. A. *Fauna of British India*, **3:** Serpents, 583 pp., 166 figs. London, 1943.

ICHTHYOLOGY.—*The fishes of the tidewater section of the Pamunkey River, Virginia.*

Edward C. Raney and William H. Massmann, Cornell University and Virginia Fisheries Laboratory.[1]

The distribution of the fish fauna of the tidewater section of most of the rivers that flow into Chesapeake Bay is poorly known. Indeed, this is true for practically all the great rivers tributary to the Atlantic from the Hudson southward to the Savannah. The few investigations usually have concentrated on commercial species and our understanding of distribution has been inferred from the knowledge of nearby Coastal Plain streams reported in such studies as those by Hildebrand and Schroeder (1928), Fowler (1945), Raney (1950), and Massmann, Ladd, McCutcheon (1952).

In 1949 the junior author began a study of the spawning and early life history of shad in the Pamunkey and other nearby Virginia rivers and collected with seines at numerous locations in the tidal area. After exploratory seining, many of the stations were visited at almost weekly intervals during the period June 28 to September 29, 1949. Since that time additional collections have been made at established stations on the Pamunkey indicated on the map (Fig. 1). A minnow seine, 20 feet long and 4 feet in depth, was used in all but six collections when a net 75 by 6 feet was employed. All seines had a bar mesh size of ¼ inch. The collections included 113 samples taken by minnow seine, 15 by surface trawl, 6 by rotenone, 4 by bottom trawl, and a series of plankton net collections which often contained small fishes. Continuous observations were made on the commercial and sport fisheries. Many of the collections were sent to the senior author, who is responsible for the identification of all but the clupeid fishes. A total of 59 species were taken in the Coastal Plain region of the Pamunkey River and its tributaries; 52 were limited to the tidewater section.

DESCRIPTION OF THE LOWER PAMUNKEY RIVER

The Pamunkey River (Fig. 1) originates on the Piedmont plateau at the confluence of the North and South Anna Rivers, 5 miles northeast of Ashland, Va., and empties into the York River at West Point. The tidal region extends about 42 nautical miles upstream to the vicinity of Bassett Bar. At West Point, salinities ranging from 0 to

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[1] Contribution from the Virginia Fisheries Laboratory.

12.6 parts per thousand have been recorded; the river generally becomes fresh between West Point and Romancoke at a point 8 miles upstream. The precise boundary between fresh and brackish water varies with river runoff, wind, and tide, as does the head of the tide itself. The tidal range averages about 3 feet. Turbidities, as measured with a Secchi disk, range from 27 to 61 cm; the upper sections of the river are generally clearer than the lower reaches. Submergent vegetation, of which the predominant form is *Nitella*, although sparse in the river, is found in abundance in a few protected coves.

The tidal portion of the river may be divided into three rather homogeneous physiographic areas each approximately 15 miles in length. Area I (Fig. 1) is characterized by a wide channel which is from 20 to 60 feet deep and rather steep mud banks. It is surrounded by extensive tidal marshes. Eight small gravel and/or sand beaches are present in this section. Area II is centered near Lester Manor. Here the river generally is wider, and is fed by many marsh creeks. Shoal areas, less than 5 feet in depth, are extensive, and numerous coves are present. The shoreline is mostly wooded. About a dozen sand and/or gravel beaches suitable for seining are present. Area III has an average depth of 12 feet, and few shoal areas, which are located in the mouths of tributary creeks. The muddy banks are rather steep and only about six small sand and/or gravel beaches are suited to seining. The shoreline is generally forested.

FISHERIES OF THE PAMUNKEY RIVER

The American shad and catfishes (*Ictalurus*) are the major species of commercial importance on the Pamunkey River. Shad are caught during the spawning run in spring, mainly with drift gill nets, although a few set or stake gill nets are fished at West Point. In depth the drift nets may be

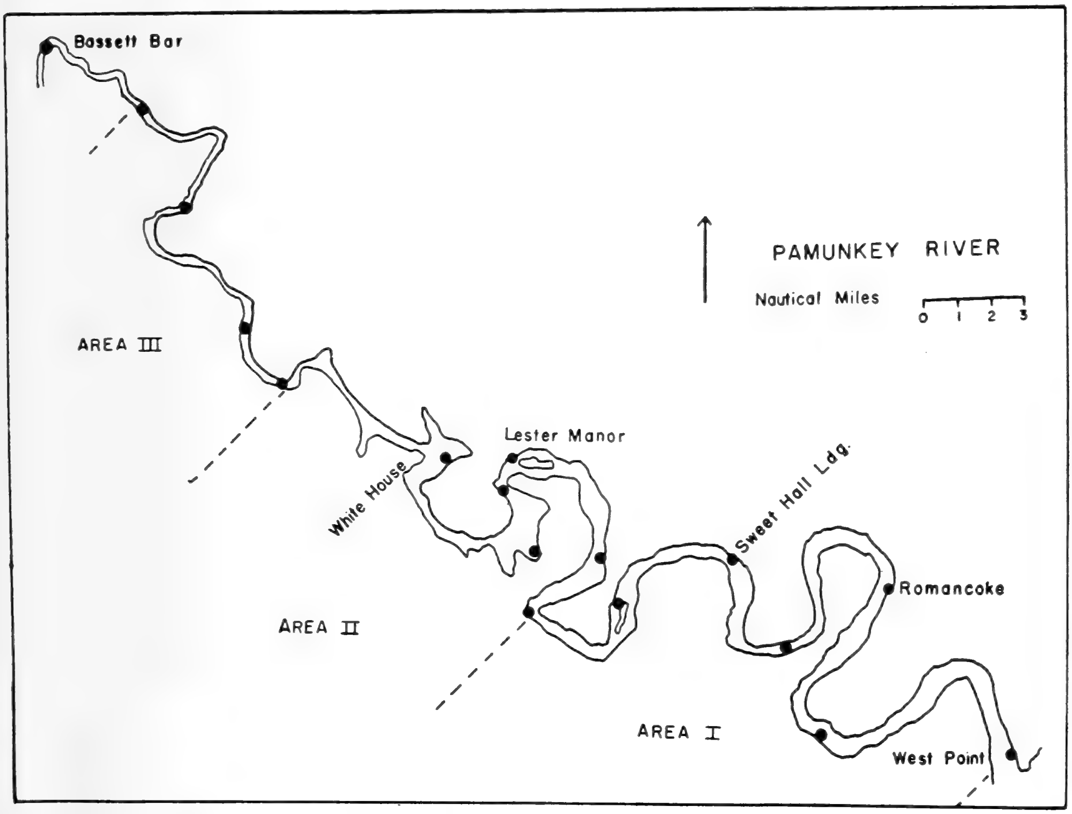

FIG. 1.—The tidewater section of the Pamunkey River between its mouth at West Point and Bassett Bar a point approximately 42 nautical miles upstream, showing localities mentioned in text

as much as 25 feet, depending on the water depths being fished; in length they vary from one-quarter to one-half the width of the channel. In area I, striped bass are often taken in shad nets. The alewife, glut herring, and hickory shad are also captured but generally, because of their smaller size, these fishes escape through the meshes of shad nets. A few small hoop fyke nets are fished in area I and their catch includes white perch, glut herring, alewife, and catfishes. In the vicinity of Lester Manor, a single haul seine operates and takes white perch, carp, striped bass, gizzard shad, and redhorse sucker. Catfishes are generally taken in catfish pots although two fishermen still use the more primitive trot lines. With the exception of catfish pots, White House is the upper limit of commercial fishing on the Pamunkey, since the river beyond that point is not suited to the use of commercial nets.

To obtain small quantities of fish for local consumption herring drift nets and set gill nets are sometimes used. Extensive angling is not carried on, but striped bass, largemouth bass, catfishes, white perch, yellow perch and sunfishes are taken.

ANNOTATED LIST OF FISHES

The following annotated list includes only those fishes taken in the tidewater section. Their distribution in the several areas of the river is given in Table 1. The number appearing at the end of each species account represents the percentage frequency of occurrence in seine hauls. (See also Table 2.)

PETROMYZONTIDAE

Petromyzon marinus Linnaeus: Sea Lamprey

Although no sea lamprey was caught or observed during the survey, it has been seen in the adjacent Chickahominy and Rappahannock Rivers. Local fishermen reported its capture in past years when nets of smaller mesh were commonly used.

ACIPENSERIDAE

Acipenser oxyrhynchus (Mitchill):
Atlantic Sturgeon

A small specimen was taken in a shad drift net at Lester Manor. Formerly common, it is now seldom seen.

TABLE 1.—Phylogenetically arranged list of the Coastal Plain fishes of the Pamunkey River system. Areas I, II, and III are from the tidewater section of the lower Pamunkey River as shown in Fig. 1. Area IV represents collections from tributaries to the tidewater section and the upstream Pamunkey River from Bassett Bar to the Fall Line. Species marked by an asterisk were also collected in the Piedmont region of the Pamunkey River system. Type of record: X—collected, O—observed, R—reliably reported by fishermen.

Species	Area			
	I	II	III	IV
Petromyzon marinus		R		
Acipenser oxyrhynchus		O		
Lepisosteus o. osseus	X	X		
Amia calva		X	X	
Alosa mediocris	X	X		
Alosa aestivalis	X	X	X	
Alosa pseudoharengus	X	X	X	
Alosa sapidissima	X	X	X	
Brevoortia tyrannus	X	X		
Dorosoma cepedianum	X	X		
Anchoa m. mitchilli	X	X		
*Erimyzon o. oblongus**				X
*Moxostoma macrolepidotum**	X	X	X	
Cyprinus carpio		O		
*Semotilus corporalis**	X		X	X
*Semotilus a. atromaculatus**				X
*Hybopsis leptocephalus**				X
Notemigonus c. crysoleucas	X	X	X	X
Notropis amoenus			X	
Notropis hudsonius saludanus	X	X	X	X
*Notropis analostanus**	X	X	X	X
Hybognathus nuchalis regius	X	X	X	X
Ictalurus catus	X	X	X	X
Ictalurus p. punctatus	X	X	X	
Ameiurus natalis erebennus	X	X		X
*Ameiurus n. nebulosus**	X			X
Schilbeodes mollis	X	X	X	
*Schilbeodes m. marginatus**		X		X
Umbra pygmaea				X
*Esox niger**	X		X	X
*Esox americanus**			X	X
*Anguilla rostrata**	X	X	X	X
Fundulus heteroclitus macrolepidotus	X	X	X	
Fundulus d. diaphanus	X	X	X	X
Gambusia affinis holbrooki	X	X	X	X
*Aphredoderus s. sayanus**				X
Strongylura marina		X	X	
Roccus saxatilis	X	X	X	X
Morone americana	X	X	X	X
Perca flavescens	X	X	X	X
Etheostoma nigrum olmstedi	X	X	X	X
Micropterus s. salmoides	X	X	X	X
*Lepomis gibbosus**	X	X	X	X
*Lepomis m. macrochirus**	X	X	X	X
*Lepomis auritus**	X	X	X	X
Centrarchus macropterus				X
Pomoxis nigromaculatus	X	X	X	X
Enneacanthus gloriosus	X	X	X	X
Enneacanthus obesus	X			
*Acantharcus pomotis**				X
Menidia beryllina	X	X	X	
Menidia menidia	X	X		
Peprilus alepidotus	X			
Cynoscion regalis	X			
Leiostomus xanthurus	X			
Micropogon undulatus	X	X		
Gobiosoma bosci	X			
Paralichthys dentatus	X			
Trinectes maculatus	X	X	X	

LEPISOSTEIDAE

Lepisosteus osseus osseus (Linnaeus): Eastern Longnose Gar

Numerous in areas I and II. On one boat trip large numbers of adults were observed near the surface between West Point and White House. One shad fishing reach near Lester Manor is seldom used because the gar, which damage shad nets, is so abundant in the area. Only three young gar were taken by minnow seine. 4.

AMIIDAE

Amia calva Linnaeus: Bowfin

Several were observed on the beach at the Pamunkey Indian Reservation where they had been discarded from gill net catches, and two were collected near Bassett Bar. Fishermen reported an increase in abundance in recent years.

CLUPEIDAE

Alosa mediocris (Mitchill): Hickory Shad

It migrates into the Pamunkey in spring to spawn and females in various stages of ripeness, and spent specimens were frequently seen although Hildebrand and Schroeder (1928, p. 84) reported to the contrary. This species was observed in commercial catches from West Point to White House. Although only three juveniles were collected while seining, 91 young were taken in two 15-minute hauls with a surface trawl in area I. 2.

Alosa aestivalis (Mitchill): Glut Herring

The most abundant of the river herrings. It generally spawns in tidal waters, but sometimes also in the tributaries. The main spawning migration follows that of the American shad, and usually occupies about three weeks. During this short but heavy run, canneries are often supplied with more herring than they can utilize, hence the common name, glut herring. However, this herring generally is not taken commercially on the Pamunkey since almost the entire fishing effort is directed toward the more valuable American shad. Juveniles are present in large numbers during the summer months and probably constitute one of the most important forage fishes. Young glut herring were collected at most stations from brackish waters to the head of tidewater. 35.

Alosa pseudoharengus (Wilson): Alewife

The main spawning run generally precedes that of the American shad by several weeks. Spawning often takes place in tributaries, but also in tidal waters. Young have been taken from all sections of the river. 17.

Alosa sapidissima (Wilson): American Shad

The main spawning run arrives in April although a few adult shad have been observed in the commercial catch from November to July. Spawning takes place in the freshwater tidal section of the river but is most concentrated in area II, as reported by Massmann (1952). Young shad were taken at most stations in fresh tidal waters. Greater numbers of young shad have been collected in the Pamunkey than in the Mattaponi or Rappahannock rivers. 57.

Brevoortia tyrannus (Latrobe): Menhaden

Although the menhaden is primarily a marine species, young are often found in fresh water. From area I, postlarval menhaden 20 to 30 mm. in length were collected in plankton nets during April, 1950. In the summer young menhaden were seined at stations in areas I and II. Collections from the Rappahannock River indicate that large numbers of young may be found in fresh-water during the summer months. 5.

Dorosoma cepedianum (LeSueur): Gizzard Shad

Observed at Lester Manor, where a few were taken in shad nets. Juveniles were collected in the mouth of a tidal creek, one mile south of Sweet Hall Landing. Fishermen reported that this species has become scarce in the past ten years.

ENGRAULIDIDAE

Anchoa mitchilli mitchilli (Valenciennes): Anchovy

Although typically marine, all stages of this anchovy from post-larvae to adult, may be present in large numbers in the rivers. The occurrence of postlarval specimens in fresh water suggests that it may spawn in or near the Pamunkey. It was collected from areas I and II. 16.

CATOSTOMIDAE

Moxostoma macrolepidotum (LeSueur): Eastern Redhorse Sucker

This is the common sucker of the region. It was found in all parts of the river. Young and juveniles were taken in seines, and adults were noted in summer gill net catches. 20.

Cyprinidae

Cyprinus carpio (Linnaeus): Carp

Occasionally taken in the haul seine operated from Lester Manor. Not common in the Pamunkey but the carp is fished commercially in both the Chickahominy and James rivers.

Semotilus corporalis (Mitchill): Fallfish

Two juveniles were taken from area I and fourteen adults were caught in one-half hour of angling at Bassett Bar. However, the favorite habitat of this form is upstream from the Fall Line. 2.

Notemigonus crysoleucas crysoleucas (Mitchill): Eastern Golden Shiner

A sluggish water form which was taken more frequently in coves than from the river channel. Collected at many locations between brackish water and the head of tidewater. 6.

Notropis amoenus (Abbott): Attractive Shiner

A single juvenile was taken in area III. Typically found upstream in pools usually near moving water. 1.

Notropis hudsonius saludanus (Jordan and Brayton): Southern Spottail Shiner

This gregarious shiner, one of the most common fishes in the shore zone, was taken in all sections of the river. It is probably an important forage fish. 63.

Notropis analostanus (Girard): Satinfin Shiner

This shiner was slightly more abundant than the spottail shiner in collections made during 1949, 1950, and 1951. In 1952 the spottail shiner appeared in approximately the same abundance as in previous years, but the satinfin shiner was scarce. It is an excellent bait minnow. 60.

Hybognathus nuchalis regius (Girard): Eastern Silvery Minnow

This common minnow, taken from all three river areas was generally more abundant in the river proper than in coves. 20

Ameiuridae

Ictalurus catus Linnaeus: White Catfish

An important commercial species and common in most of the river. It was seined about as frequently as the channel catfish. Fishermen reported that the white catfish will not enter catfish pots as readily as the channel catfish, and often used underwater fyke nets in areas where the former is more abundant. 12.

Ictalurus punctatus punctatus (Rafinesque): Channel Catfish

This introduced species is of about equal importance commercially as the native white catfish. The catfish fishery on the Chickahominy River was described by Menzel (1943). 10.

Ameiurus natalis erebennus Jordan: Southern Yellow Bullhead

Adults and young, taken in only three collections, were found in areas I and II. This species is common in the Chickahominy River.

Ameiurus nebulosus nebulosus (LeSueur): Northern Brown Bullhead

Collected only once in the Pamunkey at Sweet Hall Landing. It is common in some of the ponds near the tidewater section and was taken frequently in collections from the Rappahannock River. Fishermen reported that it occasionally was taken on the mud flats by set gill nets.

Schilbeodes mollis (Hermann): Tadpole Madtom

Adults and young were taken from all three areas and it was more abundant it coves than in the river proper. 6.

Schilbeodes marginatus marginatus (Baird): Common Eastern Madtom

One adult was taken in a plankton net at Lester Manor. The species is typically found in riffles at or above the Fall Line where it is fairly common. It is probably to be considered a straggler in the lower river.

Esocidae

Esox niger (LeSueur): Chain Pickerel

Adults were taken from a cove at Sweet Hall Landing and a creek mouth at Bassett Bar. This species seems to avoid tidal waters where local fishermen also reported it as rare. It is fairly common in the tributaries and upstream from the Fall Line.

Esox americanus Gmelin: Bulldog Pickerel

Like the chain pickerel this species is seldom seen in the tidal section of the river. Several were collected at the mouth of a tidal creek near Bassett Bar.

ANGUILLIDAE

Anguilla rostrata (Le Sueur): American Eel

This eel was collected at almost every locality on the Pamunkey River. Many elvers were taken in plankton nets during the spring. 17.

CYPRINODONTIDAE

Fundulus heteroclitus macrolepidotus (Walbaum): Mummichog

A more typically marine killifish which was taken most frequently near saltwater, but was found throughout the tidewater section. 7.

Fundulus diaphanus diaphanus (Le Sueur): Eastern Banded Killifish

Slightly more than one-half of the seine collections contained this killifish. It was common in hauls from stations near brackish water to the head of the tide. 55.

POECILIIDAE

Gambusia affinis holbrooki (Girard): Eastern Mosquitofish

A typical quiet water Coastal Plain form which more frequently appeared in hauls made in coves and backwaters. It was taken in each of the three river areas. 18.

BELONIDAE

Strongylura marina (Walbaum): Atlantic Needlefish

This marine species was collected only in areas II and III, but undoubtedly occasionally occurred in area I. One specimen 23 mm. in length was taken by dip net at Lester Manor in April. This species and other members of the Belonidae are well known for their habit of entering freshwaters and are sometimes found far from the sea. 2.

SERRANIDAE

Roccus saxatilis (Walbaum): Striped Bass

Young were taken in seine collections from all three river areas. Tresselt (1952) found striped bass eggs only in area I. Adults, often taken in the spring by shad fishermen, occur most frequently downriver from Lester Manor. However, anglers have taken striped bass in June ten miles above Bassett Bar. The species appears to be more abundant in both the Mattaponi and Rappahannock rivers than in the Pamunkey. 35.

Morone americana (Gmelin): White Perch

A common and widely distributed species collected in more than half of the seine hauls between brackish water and the head of the tide. Although frequently seined it does not appear to be as abundant in the Pamunkey as in the James or Rappannock rivers. In the past it was taken in set gill nets fished near Lester Manor in January or February but this fishery has been discontinued. Most of the white perch now taken are captured in hoop fyke nets located in area I. 54.

PERCIDAE

Perca flavescens (Mitchill): Yellow Perch

Collected mostly in coves and creek mouths from all three river areas. 12.

Etheostoma nigrum olmstedi (Storer): Tessellated Johnny Darter

Common and widespread, this species was taken in more than one-half the seine collections in all areas of the river. 53.

CENTRARCHIDAE

Micropterus salmoides salmoides (Lacépède): Northern Largemouth Bass

Taken in collections from all three areas, but appears to prefer creeks and coves to the river proper. 7.

Lepomis gibbosus (Linnaeus): Pumpkinseed Sunfish

Captured in samples from all areas and was taken about one-half as often as the bluegill. 16.

Lepomis macrochirus macrochirus Rafinesque: Common Bluegill

A widespread and common species which apparently exceeds the other sunfishes in abundance. 36.

Lepomis auritus (Linnaeus): Yellowbelly Sunfish

Found throughout the river. It appears to be more typically a river fish than are the other centrarchids, for it was more abundant in collections from the main stream than in coves. However, it also is widespread in its upstream distribution and is often common in small tributaries. 22.

Pomoxis nigromaculatus (LeSueur): Black Crappie

Occurred in scattered collections from all three river areas. 10.

Enneacanthus gloriosus (Holbrook): Bluespot Sunfish

Taken in collections from brackish waters to the head of the tide. It was more abundant in coves than in the river proper. 11.

Enneacanthus obesus (Girard): Banded Sunfish

Taken only once in the mouth of a creek at Sweet Hall Landing.

ATHERINIDAE

Menidia beryllina (Cope): Glassy Silverside

Collections from all areas of the river included this species and it appears to be more abundant in the tidal freshwaters than in salt water. Although abundant in collections from the river course, it was seldom taken in coves. 24.

Menidia menidia (Linnaeus): Atlantic Silverside

Occurred in areas I and II and is common in Chesapeake Bay. This species occasionally is found in freshwater. 6.

STROMATEIDAE

Peprilus alepidotus (Linnaeus): Harvestfish

Several were taken by surface trawl 5 miles upriver from West Point. When collected at high tide the surface salinity was 8.9 parts per thousand but on the succeeding low tide the water at that location became fresh. Harvest fish have been collected from waters of even lower salinity in the Mattaponi River but have not yet been found by us in water that was completely fresh.

SCIAENIDAE

Cynoscion regalis (Bloch and Schneider): Gray Squeteague

Young were taken by surface trawl in the freshwaters of area I. This species is generally found in salt water, but was recorded from freshwater by Gunter (1942).

Leiostomus xanthurus Lacépède: Spot

Young spot 20 to 40 mm. in length were taken in plankton nets while juveniles were collected by seine and surface trawl in area I. Spot was taken in both fresh and brackish waters. In the Rappahannock River it was collected 23 miles above brackish water and young have also been taken in the freshwaters of Mattaponi River. 3.

Micropogon undulatus Linnaeus: Atlantic Croaker

Young 20 to 30 mm. in length were collected in plankton nets in area I and small specimens were taken in plankton nets set at Lester Manor (area II) in March, 1949. Both croaker and spot have been recorded previously from freshwater by Gunter (1942). Their occurrence in freshwater at such a small size is unusual, for both species are believed to spawn in the ocean outside of Chesapeake Bay. Young of both species have also been taken in plankton nets in freshwaters of the Mattaponi River.

GOBIIDAE

Gobiosoma bosci Lacépède: Naked Goby

Several specimens were collected in one seine haul five miles above West Point. This species is commonly taken near oyster beds which are not found in the Pamunkey River. 1.

HIPPOGLOSSIDAE

Paralichthys dentatus (Linnaeus): Summer Flounder

A single specimen of this typically salt-water species was seined 5 miles above West Point. It is commonly caught commercially in the York River below West Point. 1.

ACHIRIDAE

Trinectes maculatus (Bloch and Schneider): Hogchoker

Young were especially common in the tidal freshwaters. It was taken in many samples from the mouth of the Pamunkey River to the head of the tide. 28.

FISHES OF ADJACENT SECTIONS

Scattered collections were made in small streams tributary to the tidewater section and from the Coastal Plain area of the Pamunkey upstream from the limit of Bassett Bar (area III). The tributary streams were typically clear and shallow with sand bottom and slight gradient, and all flow through wooded areas. Two of the best stations were located in pools just below mill dams. The stations in the Pamunkey River above area III were deep with steep banks which made seining difficult. Fishes taken in the above situations were *Erimyzon oblongus oblongus* (Mitchill), eastern creek chubsucker; *Semotilus atromaculatus atromaculatus* (Mitchill), northern creek chub; *Hybopsis leptocephalus* (Girard), Carolina chub; *Umbra pygmaea*, eastern mudminnow; *Aphredoderus sayanus sayanus* (Gilliams), eastern pirateperch; *Centrarchus macropterus* (Lacépedè), flier; and *Acantharcus pomotis* (Baird), mud sunfish.

In five collections made in Pamunkey River and tributaries above the Fall Line in Louisa and Hanover counties, 12 additional forms not listed in Table 1 were captured. They are as follows: *Catostomus c. commersoni* (Lacépède), *Hypentelium nigricans* (LeSueur), *Hybopsis micropogon* (Cope), *Exoglossum maxillingua* (LeSueur), *Chrosomus oreas* Cope, *Clinostomus vandoisulus* (Valenciennes), *Notropis cornutus cornutus* (Mitchill), *Notropis procne procne* (Cope), *Hadropterus notogrammus* Raney and Hubbs, *Hadropterus peltatus peltatus* (Stauffer), *Etheostoma nigrum* Rafinesque subsp., *Etheostoma vitrea* (Cope). These limited data on Piedmont fish distribution indicate that in this respect the Pamunkey River is much like the James River, as reported by Raney (1950, p. 189).

RELATIVE ABUNDANCE

The abundance of fishes is sometimes measured by their frequency of occurrence in collections made by seine hauls. This method has some limitations especially in large rivers. Recent investigations on the clupeid fishes reported by Massmann, Ladd, and McCutcheon (1952) has indicated that seining is not always a reliable measure of abundance. Other groups, such as the catfishes, are primarily nocturnal, and therefore estimations of abundance based on daytime seine hauls may be erroneous. Fishes such as the hogchoker and eel often burrow in the mud where they are easily missed by minnow seines. The young of several species, such as longnose gar, bowfin and carp rarely

Table 2.—Fishes taken in the tidewater section of the Pamunkey River arranged in order by frequency of occurrence in percentage of seine hauls. Some species are included here with full realization that seine collections do not reveal their true relative abundance.

Species	Frequency of occurrence in percent	Species	Frequency of occurrence in percent
Notropis hudsonius saludanus	63	*Anchoa m. mitchilli*	16
Notropis analostanus	60	*Lepomis gibbosus*	16
Alosa sapidissima	57	*Ictalurus catus*	12
Fundulus d. diaphanus	55	*Perca flavescens*	12
Morone americana	54	*Enneacanthus gloriosus*	11
Etheostoma nigrum olmstedi	53	*Ictalvrus punctatus*	10
Lepomis m. macrochirus	36	*Pomoxis nigromaculatus*	10
Alosa aestivalis	35	*Fundulus heteroclitus macrolepidotus*	7
Roccus saxatilis	35	*Micropterus s. salmoides*	7
Trinectes maculatus	28	*Menidia menidia*	6
Menidia beryllina	24	*Notemigonus c. crysoleucas*	6
Lepomis auritus	22	*Schilbeodes mollis*	6
Moxostoma macrolepidotum	20	*Breevoortia tyrannus*	5
Hybognathus nuchalis regius	20	*Lepisosteus o. osseus*	4
Gambusia affinis holbrooki	18	*Leiostomus xanthurus*	3
Anguilla rostrata	17	*Strongylura marina*	2
Alosa pseudoharengus	17	*Semotilus corporalis*	2
		Alosa mediocris	2
		Notropis amoenus	1
		Gobiosoma bosci	1
		Paralichthys dentatus	1

Table 3.—Relative abundance of the most common Pamunkey fishes seined in coves and in the river proper. The numbers are the ratios between the percentages of occurrence in seine hauls at the two habitats.

Species	River proper	Coves
Menidia beryllina	4.7	1.0
Hybognathus nuchalis regius	3.7	1.0
Trinectes maculatus	3.3	1.0
Lepomis auritus	3.0	1.0
Roccus saxatilis	2.0	1.0
Moxostoma macrolepidotum	1.6	1.0
Anchoa m. mitchilli	1.5	1.0
Notropis hudsonius saludanus	1.4	1.0
Fundulus heteroclitus macrolepidotus	1.3	1.0
Etheostoma nigrum olmstedi	1.1	1.0
Alosa aestivalis	1.0	1.1
Notropis analostanus	1.0	1.1
Ictalurus catus	1.0	1.1
Morone americana	1.0	1.1
Pomoxis nigromaculatus	1.0	1.1
Anguilla rostrata	1.0	1.2
Alosa sapidissima	1.0	1.4
Fundulus d. diaphanus	1.0	1.4
Gambusia affinis holbrooki	1.0	1.6
Micropterus s. salmoides	1.0	1.7
Enneacanthus gloriosus	1.0	2.5
Perca flavescens	1.0	2.9
Lepomis gibbosus	1.0	3.7
Lepomis m. macrochirus	1.0	4.0
Schilbeodes mollis	1.0	5.0
Alosa pseudoharengus	1.0	5.5
Notemigonus c. crysoleucas	1.0	13.0

are taken in minnow seines, in Virginia rivers, even though adults may be numerous. Densely schooling fishes such as the glut herring and menhaden may be far more abundant than their percentage of occurrence in seine hauls would indicate merely because these schools may be met infrequently while fishes of more uniform distribution would ordinarily be taken more often. Anadromous species, which make up a considerable part of the fish fauna in tidal rivers, may be present for only part of the year in any given ontogenetic stage, and sampling therefore is representative only of the season when collecting occurred.

The percentage of seine collections in which the various species occurred is given in Table 2. The spottail shiner was taken most frequently followed by satinfin shiner, American shad, banded killifish, white perch, and johnny darter, all of which appeared in more than one-half of the seine hauls. Next in order of frequency of capture are the bluegill sunfish, glut herring, striped bass, hogchoker, glassy silverside and yellowbelly sunfish. The remaining fishes occurred in 20 per cent or fewer seine hauls.

DISTRIBUTION

The habitat in which sampling is done is of considerable importance in determining the species that are taken. Even in a tidal river, where the various habitats tend to be unified by the influence of a mass of water of rather uniform physical and chemical characteristics (excluding the brackish waters), there are some differences in the environmental preferences of fishes.

A distinct contrast is evident between coves, where the water is not affected by tidal currents, and the river proper where the effect of such currents is pronounced. The occurrence of fishes at cove and river stations is summarized in Table 3. Glassy silverside, silvery minnow, hogchoker, yellowbelly sunfish, and striped bass were collected more frequently in the river while golden shiner, alewife, tadpole madtom, bluegill sunfish, pumpkinseed sunfish, yellow perch and bluespot sunfish occurred more often in coves. The other species were intermediate. With the exception of the alewife, those fishes favoring the cove habitat are generally found in sluggish water or ponds throughout their range, while those common to the river may or may not be found in still water in other parts of their range.

It seems evident that the species of fishes obtained by sampling rivers was determined in part by the type of habitat sampled. Therefore, care must be exercised in selecting various locations that are adequately representative of all conditions. This is a difficult problem in rivers where sampling locations, especially by seine, are limited by water depth and bottom type.

LITERATURE CITED

FOWLER, HENRY W. *A study of the fishes of the southern Piedmont and Coastal Plain.* Acad. Nat. Sci. Philadelphia Monogr. **7:** 1–408, 313 figs. 1945.

GUNTER, GORDON. *A list of fishes of the mainland of North and Middle America recorded from both freshwater and sea water.* Amer. Midl. Nat. **28**(2): 305–326. 1942.

HILDEBRAND, SAMUEL F., and SCHROEDER, WILLIAM C. *Fishes of Chesapeake Bay.* Bull. U. S. Bur. Fish. **43** (1927, pt. 1): 1–366, 211 figs. 1928.

MASSMANN, WILLIAM H. Characteristics of spawning areas of shad, Alosa sapidissima (Wilson) in some Virginia streams. Trans. Amer. Fish. Soc. **81:** 78–93, 3 figs. 1952.

MASSMANN, WILLIAM H., LADD, ERNEST C. and MCCUTCHEON, HENRY N. *A surface trawl for sampling fishes in tidal rivers.* Trans. North Amer. Wildlife Conf. **17:** 386–392, 3 figs. 1952.

MENZEL, R. WINSTON. *The catfish industry of Virginia.* Trans. Amer. Fish. Soc. **73:** 364–372, 1 fig. 1945.

TRESSELT, ERNEST F. *Spawning grounds of the striped bass,* Roccus saxatilis (*Walbaum*), *in Virginia.* Bull. Bingham Oceanogr. Coll. **14**(1): 98–110. 1952.

RANEY, EDWARD C. *Freshwater fishes.* [In] *The James River Basin, past, present and future:* 151–194. Virginia Academy of Sciences, 1950.

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