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OBSERVATIONS ON THE BIRDS OF NORTHEASTERN IDAHO

BY

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Several important papers have been published relative to the occurrence and distribution of birds in northern Idaho, notably by Merrill (1897, 1898), Rust (1915), Burleigh (1923), Hand (1941), and Johnson (1949). Very little information, however, is available regarding the avifauna of the Selway-Bitterroot region which lies considerably to the south and east of any of the areas encompassed in the previously mentioned reports. This is evident in Arvey's check-list of the birds of Idaho (1947) in which are included most of the published records relating to avian distribution in that state.

Aware of this deficiency in our knowledge of both the birds and mammals of this particular region, the writer devoted the month of September, 1941, to collecting and observing higher vertebrates in the Clearwater Mountains of Idaho County, Idaho. These studies were continued during July, 1948, in the northwestern part of the adjacent Bitterroot Mountains, farther east in the same county. It was possible, therefore, from the collections and observations made during these two months, to gain a fair impression of the avian composition of this area in summer and autumn.

R. L. Hand *(supra cit.,* pp. 220-232), who made observations over a period of a good many years in the St. Joe National Forest farther north in Idaho, remarked upon the rather significant differences between the avifauna of that country and that of the Lochsa River drainage some forty to fifty miles farther south. He attributed these, at least in part, to the change from a typically dominant white pine forest in the former area to a cedar-fir forest at comparable elevations in the latter region. The present study confirmed some of these suggested differences and, as will be seen upon comparison with Hand's list, indicates even others.

The Clearwater and Bitterroot mountain systems essentially constitute one continuous range, although their geological histories differ somewhat. According to Lindgren (1904) the Clearwaters were originally a plateau formed by two uplifts in Mesozoic times. Each of these uplifts was succeeded by a period of active erosion. At a much later date the movement of a fault about sixty miles long in the eastern part of this region resulted both in the formation of the Bitterroot Mountains, along whose summits the Idaho-Montana boundary line now extends, and the low Bitterroot Valley to the eastward in western Montana. Little evidence of Pleistocene glaciation is to be found in the Clearwaters, whose peaks presently range from 6,000 to 8,000 feet in height. The Bitterroots, however, which are several thousand feet higher were obviously subjected to intense glacial action.

The Clearwater Mountains, therefore, as was pointed out by Van Dyke (1919) with regard to their insect fauna, represent a region that is old in a biological sense. The area is characterized, climatically, both by relatively high precipitation and by high humidity (Orr, 1943). This is reflected in the vegetation which is of a rain-forest type, containing many species that are dominant along the humid, Pacific northwest, coastal belt. The floral composition differs so markedly from that to the east and south in the Rocky Mountains, as well as from that of the relatively arid Columbian plateau to the west, that Pitelka (1941) referred to it as the Coastal-Montane Forest Ecotone, and Munro and Cowan (1947) named the northward extension of this same rain forest, in southeastern British Columbia, the Columbian Forest Biotic Area. Its existence, therefore, seems likely to have been a significant factor responsible for the eastward extension of the ranges of at least a few species of birds, such as the Vaux swift, chestnut-backed chickadee, and Townsend warbler. To be sure, none of these species is confined to the coastal and inland rain forests in the Pacific northwest, but it is here that their populations are principally centered.

Throughout the extensive mountain systems under discussion, except in areas denuded by fire, the slopes below 5,000 feet elevation are covered with dense coniferous forests composed principally of Douglas fir *(Pseudotsuga taxifolia)*, grand fir *(Abies grandis)*, western red cedar *(Thuja plicata)*, western yew *(Taxus brevifolia)*, and occasionally some yellow pine *(Pinus ponderosa)*. The undergrowth is extremely dense. Locally, red cedar may be found in relatively pure stands and frequently there is a downward infiltration of various species of trees characteristic of the higher altitudes.

Above 5,000 feet, in general, the forest composition changes to Englemann spruce *(Picea englemannii)*, alpine fir *(Abies amabilis)*, western white pine *(Pinus monticola)*, lodgepole pine *(Pinus contorta* var. *murryana)*, and some western larch *(Larix occidentalis)*. At 7,000 feet open, subalpine forests of white bark pine *(Pinus albicaulis)*, with an undergrowth of red heather *(Phyllodoce empetriformis)*, Labrador tea *(Ledum glandulosum)*, and other Hudsonian plants are common and extend to timber line which occurs at an average elevation of 7,500 feet.

Since many parts of this region have been subjected to severe fires in past years, there are extensive tracts of brushland in which second growth, coniferous forests are slowly making their appearance. Meadows, however, even of small size, are extremely scarce.

During the two periods previously referred to in which the writer had opportunity to observe and collect higher vertebrates in this part of northeastern Idaho, sixty-seven species of birds were definitely recorded. This number represents approximately one-fourth of the avian species listed by Arvey (1947) as occurring or having occurred within historic times in the entire state.

In September, 1941, activities were confined principally to the western part of the Clearwater Mountains along the Selway Fork of the middle branch of the Clearwater River in the general vicinity of Selway Falls and, to a limited extent, the Crags Mountains. In July, 1948, field work was restricted to the headwaters of the Lochsa Fork of the middle branch of the Clearwater River, immediately west of Lolo Pass, in the northern part of the Bitterroots and the northeastern part of the Clearwaters. The writer was assisted in the field in 1941 by G. Dallas Hanna, Anatole S. Loukashkin, and Cecil Tose, and in 1948 by Dorothy B. Orr. Grateful acknowledgment is here made of the courtesies extended by the Idaho Department of Fish and Game during the course of this study.

Mergus merganser. Common merganser. Noted commonly along the middle branch of the Clearwater River between Kooskia and Selway Falls on September 5. Two individuals were observed flying downstream near Selway Falls on the evening of September 8.

Accipiter striatus velox. Sharp-shinned hawk. One specimen was secured on September 6, 2 miles south-southeast of Selway Falls. At this same locality, on September 9, another sharp-shinned hawk was seen to capture a small bird in the forest.

Accipiter cooperii. Cooper hawk. One individual was noted flying through an Englemann spruce forest 6 miles south-southwest of Lolo Pass on July 20. On September 8 a Cooper hawk was collected 2 miles south-southeast of Selway Falls.

Buteo jamaicensis. Red-tailed hawk. This species was not uncommon in July in the vicinity of Lolo Pass. Individuals were frequently observed during September near Selway Falls, especially in burned-over areas where there were many tall, standing snags.

Aquila chrysaëtos. Golden eagle. Observed 2 miles southwest of Selway Falls on September 18, and 4 miles southwest of Selway Falls on September 25.

Haliaeetus leucocephalus. Bald eagle. An adult bald eagle was seen perched on the top of a tall, dead tree on the northern slope of a burned-over ridge, 4 miles southwest of Selway Falls, on September 16.

Pandion haliaetus. Osprey. On September 5, 2 ospreys were seen along the Selway Fork of the middle branch of the Clearwater several miles below Selway Falls.

Falco sparverius. Sparrow hawk. Three individuals were seen on September 6 during the course of a 3-mile walk toward Indian Hill Lookout, southeast of Selway Falls.

Dendragapus obscurus richardsonii. Blue grouse. In July, 1948, blue grouse were found to be very scarce in the northern part of the Bitterroot Mountains and adjacent Clearwaters. Only one observation was recorded. On July 12, a female with a small group of half-grown young was seen near the junction of Pack and Brushy creeks. Local game authorities and members of the Forest Service asserted that grouse had been scarce for several years throughout the region and attributed this largely to a natural low in the population cycle of grouse rather than a result of intensive hunting.

In September, 1941, blue grouse were extremely abundant in the western part of the Clearwater Mountains. At that time their upward migration was in progress and none was seen below 4,500 feet. They were most often observed feeding along the margins of forests or in broken types of forest that was intermingled with brush and clearings. Grassland, next to mixed brush and forest and along the edges of roads, provided the next most favored feeding sites. Greatest numbers of blue grouse were seen in the early morning and late afternoon hours. These birds were usually found in coveys, composed of 4 to 8 individuals, which appeared to be family groups including adults and young of the year. Examinations of the contents of crops and stomachs indicated that the needles of larch and fir, alder buds, and grasshoppers were the principal items of food consumed by these grouse.

Between September 11 and 27, 12 specimens (8♂♂ and 4♀♀) were collected in the Selway Falls area.

Bonasa umbellus phaia. Ruffed grouse. In September, 1941, ruffed grouse were not only as abundant as blue grouse in the Selway area but were found to have a greater altitudinal distribution at this season. They were observed at elevations ranging from 1,900 feet, as in the canyon bottoms, to the tops of the ridges which here averaged about 6,000 feet. Members of this species showed a decided preference for dense forest undergrowth or extensive alder thickets and rarely ventured more than a few feet into the open. Usually, no more than 1 to 3 individuals were seen at a time. The only ruffed grouse crop and stomach examined contained fern fronds.

Fifteen specimens (10♂♂ and 5♀♀) were collected, between September 10 and 27, in the Selway region.

Otus asio. Screech owl. In the Selway region the call notes of this owl were frequently heard at night in September, both in the canyon bottoms and on the tops of the ridges. In the late afternoon of September 5 a screech owl was flushed from a tree 2 miles south-southeast of Selway Falls.

Bubo virginianus. Horned owl. Horned owls were frequently heard calling in the evening in the Selway region during September.

Glaucidium gnoma. Pigmy owl. In the late afternoon of September 16 several red-breasted nuthatches were observed harassing a pigmy owl high in a fir tree, 4 miles southwest of Selway Falls. In this same vicinity, on the night of September 21, the call notes of an owl of this species were heard.

Aegolius acadicus acadicus. Saw-whet owl. On the evening of September 12 a soft, mellow note, uttered repeatedly near our camp 4 miles southwest of Selway Falls, was attributed to one of this species. Two nights later a saw-whet owl was secured at dusk as it lit on a roadside bank at this same locality.

Chordeiles minor. Booming nighthawk. During July, in the late afternoon and early evening, nighthawks were frequently observed flying high over the canyons of Brushy Creek and Crooked Fork 4 miles south-southwest of Lolo Pass.

Chaetura vauxi. Vaux swift. This species was noted almost daily during July. Groups of from 4 to 12 individuals were seen most often in the late afternoon flying high over camp 4 miles south-southwest of Lolo Pass.

Selasphorus rufus. Rufous hummingbird. Members of this species were fairly abundant during July in the Lolo Pass region at elevations ranging from 4,000 to 7,000 feet. Individuals were most often seen in small forest clearings. An adult female was collected on July 8, 6 miles south-southwest of Lolo Pass.

Megaceryle alcyon. Belted kingfisher. Common along the larger streams during both July and September.

Colaptes cafer. Red-shafted flicker. Numerous individuals of this species were observed during both July and September in the Clearwater-Bitterroot area.

Hylatomus pileatus picinus. Pileated woodpecker. Members of this species were relatively common in the Selway region during September. They were observed in forested country at elevations ranging from 1,900 to 6,000 feet. An adult female and adult male were collected on September 13 and 17, respectively, 4 miles southwest of Selway Falls.

Sphyrapicus varius nuchalis. Yellow-bellied sapsucker. This species was noted twice 4 miles south-southwest of Lolo Pass. On July 6 an adult was observed in a small aspen grove near the entrance to a hole in one of the trees and on July 21 an immature female was collected within 100 yards of this same tree.

Sphyrapicus thyroideus. Williamson sapsucker. This species was observed only on September 23, 4 miles southwest of Selway Falls. On this date two individuals were seen, one in a Douglas fir and the other in an alpine fir.

Dendrocopos villosus monticola. Hairy woodpecker. Hairy woodpeckers were quite numerous in the Selway region in September. Individuals were noted both in burned-over areas where there were many standing snags and in forested country. Two males and a female were secured between September 10 and 23, 4 miles southwest of Selway Falls.

Dendrocopos pubescens leucurus. Downy woodpecker. A female of this species was secured on September 25 and another female on September 26, both in an area that had been burned over some years before and was presently overgrown with alder amid standing snags, 4 miles southwest of Selway Falls.

Picöides arcticus. Arctic three-toed woodpecker. A pair of these three-toed woodpeckers were seen close to a cavity in a tall dead tree on a ridge forested with Englemann spruce, western larch, alpine fir, lodgepole pine, and white pine, 6 miles south-southwest of Lolo Pass on July 13. The male was collected.

Picöides tridactylus fasciatus. Three-toed woodpecker. This species was observed on September 29, 4 miles southwest of Selway Falls, and, on both July 13 and 20, 6 miles south-southwest of Lolo Pass. On each of the latter two dates an adult male was secured. The male taken on July 13 was one of a pair observed on a dead tree in a spruce, fir, and pine forest within several hundred yards of a pair of Arctic three-toed woodpeckers.

Empidonax sp.? Flycatchers of this genus were observed almost daily during the month of July in mixed open forest and brushland in the Lolo

Pass region. Judging from the call notes and habitat occupied, the majority of individuals seen were believed to be Wright flycatchers *(E. wrightii)* but, unfortunately, no specimens were collected.

Contopus richardsonii. Wood pewee. This species was observed on but one day, September 6, when two individuals were seen in rather open forest land during the course of a 3-mile walk toward Indian Hill Lookout, southeast of Selway Falls.

Nuttallornis borealis. Olive-sided flycatcher. This species was not observed in September in the Selway region. In July, in the northeastern Clearwater and northern Bitterroot mountains, it was relatively uncommon.

Progne subis. Purple martin. On July 20 a small group of purple martins was observed flying with some Vaux swifts over the canyon at the junction of Crooked Fork and Brushy Creek, 4 miles south-southwest of Lolo Pass.

Perisoreus canadensis bicolor. Canada jay. This species was not uncommon in the higher forested parts of the Selway region. These jays were usually found in small groups. Between September 11 and 25, 5 males and 3 females were collected 4 to 5 miles southwest of Selway Falls.

Cyanocitta stelleri annectens. Steller jay. Fairly common in the Lolo Pass region during July. On July 20 an individual of this species was observed annoying a red-tailed hawk that was perched on the top of a dead tree about 6 miles south-southwest of Lolo Pass. Steller jays were more abundant, however, in forested parts of the Selway region in September. Between the 7th and 27th of that month, 3 males and 5 females were collected 2 miles south-southeast and 4 miles southwest of Selway Falls.

Corvus corax. Holarctic raven. Ravens were noted occasionally during July and September in each of the regions visited.

Nucifraga columbiana. Clark nutcracker. During July members of this species were found to be common near timber line in the northern part of the Bitterroot Mountains. On July 16 an adult male was secured 8½ miles southeast of Lolo Pass. In September this species was observed twice in the Selway region. On September 17 a flock of 15 nutcrackers were seen 4 miles southwest of Selway Falls and 3 days later a few individuals were noted in the Crags Mountains.

Parus atricapillus fortuitus. Black-capped chickadee. This species was not observed during July in the Lolo Pass region. It may quite possibly have been overlooked since two other kinds of chickadees were present. Black-capped chickadees were frequently seen in September in the Selway region at elevations ranging from 1,900 to 5,800 feet. Two females were secured on September 6, 2 miles south-southeast of Selway Falls.

Parus gambeli grinnelli. Mountain chickadee. Noted in July and September in the Lolo Pass and Selway regions, respectively. Two specimens, both males, were collected, one on July 16, 8½ miles southeast of Lolo Pass at 7,000 feet elevation and the other on September 10, 2 miles south-southeast of Selway Falls at 1,900 feet elevation.

Parus rufescens. Chestnut-backed chickadee. This species was common in forested areas, at elevations ranging from 4,000 to 6,000 feet, along the upper parts of the Lolo Trail in July.

Sitta canadensis. Red-breasted nuthatch. Common during July in the Lolo Pass region. On July 8 a pair of red-breasted nuthatches were observed carrying food to a nesting cavity in a standing snag 6 miles south-southwest of Lolo Pass. During September members of this species were frequently seen in the Selway region. On September 6, during the course of a 3-mile walk through forested country near Selway Falls, 15 individuals were counted.

Certhia familiaris. Brown creeper. Observed on July 4, 4 miles south-southwest of Lolo Pass. During September this species was recorded several times in the Selway region.

Cinclus mexicanus. American dipper. Dippers were frequently observed along watercourses in the Lolo Pass region during July, and, in the Selway region, during September. On July 6 a dipper nest containing 2 fairly large young was found attached to the sheer face of a rock about 10 feet directly above a deep, swift-flowing part of Brushy Creek, 5 miles south-southwest of Lolo Pass. Whenever an adult returned with food the young stuck their heads out of the opening in the lower part of the nest and called loudly. On one occasion the food fell into the water below just as one of the parents reached the nest. Instantly the adult dived into the swift current. Some seconds later it appeared on the surface but apparently had been unsuccessful in retrieving the lost item. On July 12 another dipper nest was found about one-half mile farther up the same stream. It was attached to a log that was overhanging a turbulent part of the stream. Two fairly large young were also present in this nest. During September, in the Selway region, dippers were occasionally heard singing.

Troglodytes aëdon. House wren. This species was recorded only once. On September 20, 2 individuals were seen at Canteen Meadow in the Crags Mountains. It is likely that they were migrants as the day was cold with snow falling by late afternoon.

Troglodytes troglodytes. Winter wren. This species was a common resident in heavily forested parts of the Lolo Pass region in July. Individuals were observed at elevations ranging from 4,000 to 7,000 feet. On July 24, a nest containing 4 small young was found beneath the exposed roots of a blueberry bush on a road bank 5 miles south-southwest of Lolo Pass. Both parents were observed carrying food to the young. One of the adults was collected. Another specimen was secured on September 21, 4 miles southwest of Selway Falls.

Dumetella carolinensis. Catbird. A single individual was collected on September 8, 2 miles south-southeast of Selway Falls.

Turdus migratorius. Robin. Abundant in July in the Lolo Pass region and in September in the Selway area.

Ixoreus naevius meruloides. Varied thrush. This species was abundantly represented in the northeastern Clearwater and northern Bitterroot mountains in July. Its local distribution corresponded rather closely to that of the winter wren. The greatest numbers of individuals were found in dense forests of spruce, fir, and, especially, western red cedar. Varied thrushes were most often heard singing between sunset and dusk. Likewise, at this time of the evening, they were frequently observed on dirt roads in the forest. During the middle of July individuals of this species were noted carrying nesting material. A laying female was collected on July 10, 4½ miles south-southwest of Lolo Pass and an adult male on July 18, 4 miles south-southwest of Lolo Pass. Another specimen was secured on September 28, 6 miles southwest of Selway Falls.

Hylocichla guttata guttata. Hermit thrush. No individuals of this species were seen or heard during the month of July in the Lolo Pass region. It is possible that they had passed the period of song and were overlooked. Two adult females were collected 4 miles southwest of Selway Falls, on September 17 and 25, respectively. These proved to be of the race *H. g. guttata* rather than *H. g. auduboni* which breeds in parts of Idaho.

Hylocichla ustulata almae. Olive-backed thrush. These thrushes were very abundant during July in the upper watershed of the Lochsa Fork. A nest containing 4 eggs was found in a clump of alders about one-half mile above the mouth of Brushy Creek on July 11. Ten days later an examination of the nest showed four young present. Their eyes were partly open at this time. Singing individuals were noted from the canyon bottoms almost to timber line. A single individual was seen and collected on September 11, 2 miles south-southeast of Selway Falls at 1,900 feet elevation. On July 6 an adult male was secured 4 miles south-southwest of Lolo Pass at 4,000 feet elevation and on July 16 another adult male was collected 8½ miles southeast of Lolo Pass at 7,000 feet elevation.

Sialia currucoides. Mountain bluebird. Many individuals were noted in the Crags Mountains on September 20. On this date a male was secured at Canteen Meadow, 9 miles northeast of Selway Falls.

Myadestes townsendi. Townsend solitaire. Members of this species were frequently observed during July in the Lolo Pass region in areas where there were scattered conifers and numerous boulders or rock slides. In September many small groups of solitaires were seen in the Selway Falls region. On occasions they were seen feeding on the berries of mountain ash and western yew. Some individuals were noted catching insects in the air. Three specimens, two males and a female, were secured on September 9 and 10, 2 miles south-southeast of Selway Falls at 1,900 feet elevation.

Regulus satrapa amoenus. Golden-crowned kinglet. Common during July in dense spruce and alpine fir forests in the Lolo Pass region. Two males, each with enlarged gonads, and each carrying food, were collected on July 8, 6 miles south-southwest of Lolo Pass at an elevation of 6,000 feet. Small groups of golden-crowned kinglets were observed a number of times in Englemann spruce forests during September and one male was secured on September 12, 4 miles southwest of Selway Falls at 5,500 feet elevation.

Anthus spinoletta pacificus. Water pipit. This species was recorded in the Crags Mountains on September 20. On this occasion several flocks were seen in open country and a female was collected at Canteen Meadow, 9 miles northeast of Selway Falls at 6,600 feet elevation.

Vireo gilvus. Warbling vireo. A few individuals were seen or heard singing, particularly in aspens or alders, in the Lolo Pass region below the 5,000-foot level during July.

Dendroica auduboni auduboni. Audubon warbler. Common during July in forested areas in the Lolo Pass region. Two breeding males were collected, one on July 9, 8½ miles southeast of Lolo Pass at 7,000 feet elevation, the other on July 13, 6 miles south-southwest of Lolo Pass at 6,000 feet elevation. This species was frequently observed during September in the vicinity of Selway Falls.

Dendroica townsendi. Townsend warbler. This appeared to be the most abundantly represented species of warbler in the Lolo Pass region in July. Townsend warblers were observed or heard in most types of coniferous forests between 4,000 and 6,000 feet elevation, but were perhaps most numerous where lodgepole pine predominated. Singing males were heard daily during July and, on July 5, 2 pairs were seen along Brushy Creek each of which appeared to have young that had just left the nest. The females of each of these pairs, when approached by the observer, displayed near the ground with fluttering wings as though attempting to distract attention from fledglings nearby. Such displays were repeated a few hours later the same day when the observer returned. In each instance this time, however, the females were some yards away from the previous scene of anxiety. On July 6, an adult male and an adult female were collected 4 miles south-southwest of Lolo Pass.

Oporornis tolmiei tolmiei. Tolmie warbler. This species was frequently observed in the Lolo Pass region during July. Pairs were most commonly seen in small forest openings where there was a dense growth of brushy shrubs. Two males were secured 4 miles south-southwest of Lolo Pass, one on July 4 and the other on July 6.

Wilsonia pusilla pileolata. Pileolated warbler. These warblers were fairly common during July in the upper part of the Lochsa Fork watershed. They were most frequently observed in alder and willow growing either along streams or in forest openings. An adult female was collected on July 4, 4 miles south-southwest of Lolo Pass.

Piranga ludoviciana. Western tanager. Noted commonly wherever there were coniferous forests in the Lolo Pass region during July. This species was noted on September 6 and 10, 2 miles south-southeast of Selway Falls. On the latter date a male was collected.

Hesperiphona vespertina brooksi. Evening grosbeak. Noted commonly during July in the Lolo Pass region. Individuals of this species were sometimes seen singly or in what appeared to be pairs but most frequently they were observed in flocks, the largest of which consisted of as many as 30 birds. Small groups were noted daily about the author's camp, frequently in company with pine siskins and red crossbills. Members of all three species seemed attracted to the ashes of the camp fire where they picked up and swallowed bits of charcoal. Two adult males with enlarged gonads were collected on July 2, 4 miles south-southwest of Lolo Pass. The testes of one measured 10 millimeters in length.

On September 23, 3 evening grosbeaks were observed 4 miles southwest of Selway Falls.

Carpodacus cassinii. Cassin finch. Individuals of this species were noted infrequently during July at higher elevations in the Lolo Pass region.

Pinicola enucleator. Pine grosbeak. Several individuals of this species were observed on September 23 and also on September 29, 4 and 6 miles southwest of Selway Falls, respectively.

Spinus pinus. Pine siskin. Pine siskins were numerous throughout forested parts of the Lolo Pass region in July. Small groups of these birds came daily to pick up bits of charcoal from the ashes of the author's camp fire. They paid little attention to bread crumbs that were placed out for them close to the ashes.

Loxia curvirostra bendirei. Red crossbill. This species was common throughout forested parts of the upper Lochsa Fork watershed during July. Wherever red crossbills were seen they were generally so numerous that it was diffcult to determine whether they were all in flocks or whether some were paired off. However, since many males were noted singing regularly and a female that was collected on July 21, 4 miles south-southwest of Lolo Pass, was laying, it appeared that some of these birds were nesting. A male secured on July 19, 6 miles south-southwest of Lolo Pass had testes 5 millimeters in length. Red crossbills, like evening grosbeaks and pine siskins came into camp regularly to secure charcoal from the campfire ashes.

Passerculus sandwichensis anthinus. Savannah sparrow. Flocks of savannah sparrows were noted on several occasions during the middle of September in open grassy situations on Burned Ridge, 4 miles southwest of Selway Falls. Four specimens (3♂♂, 1♀) secured on September 16 and 23, proved on comparison to belong to the race *P. s. anthinus* rather than *P. s. nevadensis,* the form that breeds in parts of Idaho.

Junco oreganus montanus. Oregon junco. Juncos were present, though not numerous, in the Lolo Pass region in July. Two males were secured, one on July 13, 6 miles south-southwest of Lolo Pass and the other on July 16, 8½ miles southeast of Lolo Pass. In September numerous flocks were noted in the Selway region. Three specimens were collected, 1 at Canteen Meadow, 9 miles northeast of Selway Falls on September 20 and 2 on September 11, 4 miles southwest of Selway Falls.

Spizella passerina arizonae. Chipping sparrow. Noted frequently during July in the Lolo Pass region. A male that was carrying food in its bill was collected on July 8. The gonads of this individual were noticeably enlarged. Chipping sparrows were observed during the early part of September in the Selway region. On September 6, 8 individuals were counted along the course of a three-mile walk near Selway Falls.

Zonotrichia leucophrys leucophrys. White-crowned sparrow. Members of this species were noted commonly during July in willow and alder thickets about the margins of lakes in the higher parts of the northern Bitterroot and northeastern Clearwater mountains.

Zonotrichia leucophrys gambelii. White-crowned sparrow. Numerous flocks of white-crowned sparrows were seen during the month of September in the Selway region. Four specimens collected 4 miles southwest of Selway Falls between September 11 and 16 were all migrants of the race *Z. l. gambelii.*

Passerella iliaca schistacea. Fox sparrow. Fox sparrows were exceedingly scarce in the Bitterroot-Clearwater area. The species was recorded only once. On July 8, a pair were seen in brushy growth in an open forest 6 miles south-southwest of Lolo Pass. The singing male was collected.

Melospiza melodia. Song sparrow. A single song sparrow was seen on July 20 along Brushy Creek, 4 miles south-southwest of Lolo Pass.

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NOTES ON THE CHARACID FISHES OF THE SUBFAMILY SERRASALMINAE[1]

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INTRODUCTION

The serrasalmine characins are comparatively well known among South American fishes from several points of view. The ferocity of several of the "piranhas" or "pirayas" of the genus *Serrasalmus* has made these fishes notorious; their attacks upon man are well attested and apparently not infrequent (Eigenmann, 1915, pp. 227-233). On the other hand, the members of the Serrasalminae are themselves used as food, and various aspects of their natural history have entered the literature (Eigenmann and Allen, 1942, pp. 242-245, 252). Certain of the smaller species are also known to aquarists, who have imported them from time to time (Innes, 1942, pp. 160-165).

The limits of the Serrasalminae as here dealt with are those assigned by British authors to the Serrasalmonina (Günther, 1864, p. 366) or Serrasalmoninae[3] (Boulenger, 1904, p. 576; Regan, 1911, p. 17; and Norman, 1929). American authors, on the other hand, have usually followed Eigenmann in breaking up the group into two subfamilies: (1) Serrasalminae *(sensu stricto);* (2) Mylesinae (Eigenmann, 1903, p. 147), Myleinae

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[1] Submitted for publication August, 1947.

[2] Formerly of the Museum of Zoology, University of Michigan, Ann Arbor, Michigan.

[3] In the time of Boulenger and Regan the type genus was thought to be *Serrasalmo,* the genitive of which would be Serrasalmonis. But Lacépède's original spelling of this genus, though classically incorrect, is *Serrasalmus,* the genitive of which would be Serrasalmi. The subfamily name thus becomes Serrasalminae, not Serrasalmoninae.

(Eigenmann, 1907, p. 772), or Mylinae (Eigenmann, 1910, p. 442). Gregory and Conrad (1938, pp. 321, 325-332) agree neither with Eigenmann nor with the British authors as to the limits of the subfamily, broadening it to include the Stethaprioninae (as well as the Serrasalminae and Mylinae of Eigenmann).

Of the above classifications I can find little basis for that of Gregory and Conrad. These authors give no character or group of characters by which their Serrasalmoninae can be distinguished from other characins, and I know of none. Since Eigenmann's 1907 paper, it has been generally agreed that (p. 771) "the members of the Stethaprioninae mark the direct road from the genus *Tetragonopterus* (Tetragonopterinae) in its narrowest sense to the Myleinae and Serrasalminae." However, I feel that this interpretation is open to question. Aside from a deep body and the sharpening of the midventral edge (which in characins is usually correlated with a deep body), there is only one characteristic common to the Stethaprioninae and a part of the Serrasalminae *(sensu lato)* and that is the very striking development of the predorsal spine. But the predorsal spine of the Stethaprioninae and that of the Serrasalminae are constructed on very different plans (compare Eigenmann, 1917, pl. 98, figs. 5 and 6 with Eigenmann, 1915, pl. 58); the predorsal spine of the Stethaprioninae is movably articulated with the base of the first dorsal ray, whereas that of the Serrasalminae is firmly attached to the first interneural. Furthermore, *Colossoma* and *Mylossoma* of the Serrasalminae lack the predorsal spine, and this seems not to be due to secondary loss.

The recognition of Mylinae as a subfamily equivalent to Serrasalminae (and to such other groups as Tetragonopterinae) appears to me to obscure the close relationship between the two groups. If, however, Serrasalminae is ever raised to family rank, the recognition of two subfamilies might be logical, though the nomenclatorial question would be raised whether the subfamily heretofore called Mylinae would not have become Mylesininae.[4]

The Serrasalminae as here considered, then, may be characterized by the elongate dorsal (of 16 or more rays), by the presence of scutes along at least part of the ventral midline, by the deep body and small scales, and by having a supraorbital bone.

There have been three revisions of parts of the subfamily in recent years. In 1915 Eigenmann wrote a key to the genera, and a key, with synonymies, to the species of *Serrasalmus.* In 1924 Ahl published a revision of the genus *Metynnis.* Norman's paper of 1929 contains a key to the genera, synonymies of all the species of all the genera, and revisions of *Serrasalmus, Colossoma, Mylossoma,* and *Myleus.*

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[4] If two subfamilies are recognized, it appears that *Catoprion* should be placed as an aberrant offshoot of the Serrasalminae and not with the Mylinae, to which it has hitherto been allocated. Another possibility is to recognize *Catoprion* as constituting a third subfamily.

The purposes of the present paper are (1) to redefine and re-evaluate the genera, determining their phylogenetic relationships insofar as possible; (2) to give a synopsis of the species of *Myleus* (which, as here understood, includes *Myloplus* and *Paramyloplus);* (3) to revise *Metynnis;* (4) to list all the species of the subfamily described since Norman's (1929) paper. Representatives of all of the genera of the subfamily have been examined, including the second known specimen of *Utiaritichthys,* and the first specimen of *Mylesinus* recorded since 1859. A new species, *Acnodon normani,* is described.

ACKNOWLEDGMENTS

The basis of the present work lies in the excellent collections of Serrasalminae made by Ternetz on the Rio Tocantins and along the lower Amazon, Brazil, in 1923-1924. This material is now a part of the fish collection of the California Academy of Sciences. I am much indebted to this institution, and particularly to Dr. Wilbert M. Chapman, formerly curator of fishes at the Academy, for the loan of these specimens, and for the very considerable packing and paper work entailed in shipping them. Representatives of the subfamily have been examined in the Museum of Comparative Zoology and the Carnegie Museum through the courtesy and help of Mr. William C. Schroeder and Mrs. M. M. Dick at Cambridge and of Dr. A. W. Henn, Mr. M. Graham Netting, and Dr. Grace Orton at Pittsburgh. I wish also to thank Dr. E. C. Raney and Mrs. M. M. Dick for the loan of specimens from Cornell University and the Museum of Comparative Zoology respectively. Dr. L. P. Schultz has kindly transferred to me specimens loaned to him by the California Academy of Sciences. I am obliged to Mr. Augustín Fernández for sending me a Venezuelan specimen of *Myleus,* and Mr. John W. Winn and Mr. Walter H. Chute have been good enough to give me information concerning specimens of Serrasalminae in Chicago.

MECHANICS OF THE PAPER

The synonymies are selected. Those references which do not report new names or new material, and those which record new material which is unidentifiable, are omitted.

Where a tooth formula is given, it is for one side of the mouth only. For example, the notation 5+2/5+1 means that there are five teeth in the outer and two in an inner row on each side above, and five in the outer row with a conical tooth behind the central tooth on each side below. In the suborbital series of bones, the first suborbital or lacrymal borders the nares, and the second suborbital is the first of the exposed cheek series (fig. 5). Splint-like rays at the front of fins are included in fin counts. Following the apparent usage of Norman, Eigenmann, Günther, etc., the last fin ray is included in fin counts if it is well separated from the preceding ray. Scute counts are often divided into two parts, those preceding the insertion of the ventrals and those between the ventral insertion and the anal origin; scutes alongside of the anus are included in the latter; where only a single figure is given, it is the total count.

Measurements, except standard length and depth, were made with dividers and calculated to the nearest 0.1 mm. by laying the divider points along a millimeter ruler. Such measurements were transferred to thousandths of the standard length by slide rule. The standard length, from the tip of the snout to the structural base of the caudal fin, is the only fish length used. The head is measured from the tip of the snout to the end of the bony operculum; the snout, to the anterior border of the orbit; the eye, between the membranes; the snout-dorsal distance, to the base of 1st dorsal ray; the dorsal-caudal distance, from the base of the last dorsal ray to the end of the vertebral column; and the depth of the operculum, between the extreme top and bottom ends of this bone.

The following abbreviations are used: C.A.S. for the California Academy of Sciences, C.M. for the Carnegie Museum, C.U. for Cornell University, M.C.Z. for the Museum of Comparative Zoology, and U.M.M.Z. for the University of Michigan Museum of Zoology.

TABLE 1

Comparisons of various generic characters of the Serrasalminae. Measurements based on a single specimen, those other than standard length expressed in thousandths of standard length.

	Standard length in mm.	Length of lower jaw	Greatest width of third sub-orbital	Depth of body	Length of rayed dorsal base	Length of adipose dorsal base	Bases of rayed and adipose dorsals combined
Colossoma bidens	120	111	42	623	217	50	268
Colossoma nigripinne....	165	126	54	582	205	41	246
Mylossoma aureum	112	77	33	698	194	47	241
Mylesinus schomburgkii	205	94	26	513	270	35	305
Utiaritichthys sennae-bragai	168	85	29	601	259	54	332
Myleus setiger	106	97	35	703	309	51	360
Myleus (gurupyensis?)..	105	96	30	661	360	31	392
Acnodon normani	114	84	25	553	222	85	307
Metynnis hypsauchen	105	86	36	786	240	193	433
Metynnis argenteus........	123	90	33	789	213	173	386
Catoprion mento	103	135	71	657	205	97	301
Pygopristis denticulatus	162	125	67	592	229	75	304
Serrasalmus nattereri....	210	163	134	576	248	45	293
Serrasalmus striolatus....	116	135	62	614	215	158	372
Serrasalmus elongatus....	162	157	62	420	151	35	186

Phylogeny and Classification of Serrasalmine Genera

The following structures seem to be of primary importance in the classification of the genera of Serrasalminae: dentition, scutation of the mid-ventral line, lengths of the dorsal fins, presence or absence of a predorsal spine, and size of the suborbital bones.

All of these characters appear to be correlated with the form and food habits of these fishes. In the genera of Serrasalminae there is a close positive correlation between the length of the lower jaw and the greatest width of the third suborbital (table 1, fig. 1, and fig. 5). That this is a functional correlation is borne out by the jaw musculature. In the characins, the muscles of the lower jaw originate in part on the suborbital bones but also in part on the inside surface of the suborbital bones. Other things being equal,

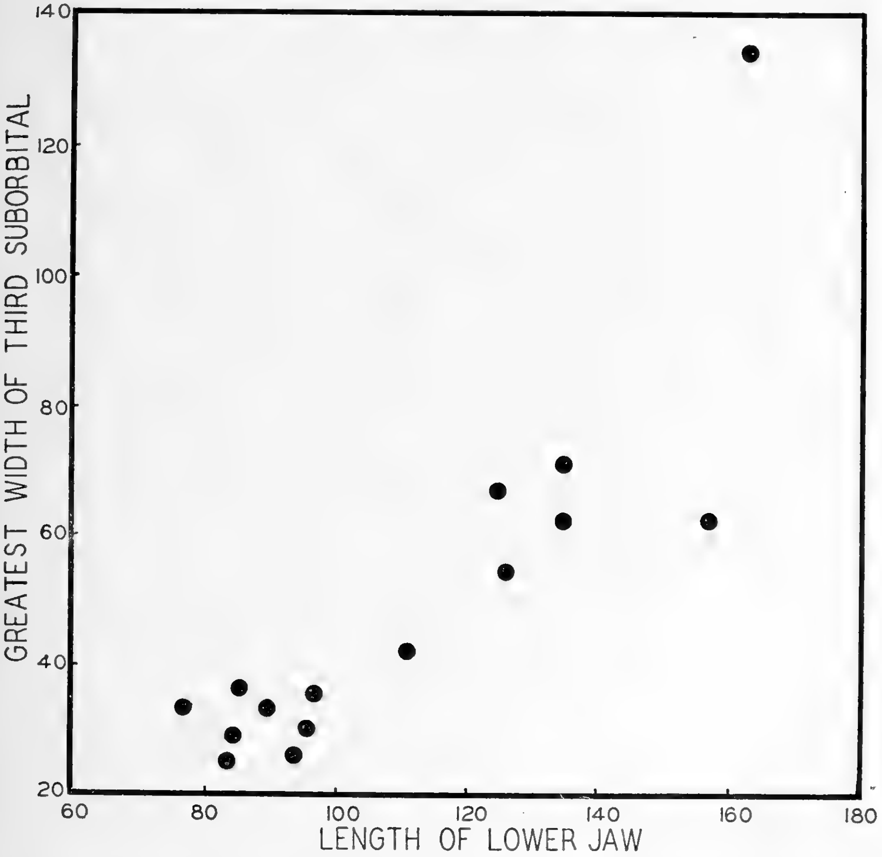

Figure 1. Correlation between length of lower jaw and greatest width of third suborbital in fifteen species of Serrasalminae. Data from table 1. All measurements expressed as thousandths of standard length.

it takes a greater amount of musculature to close the jaw of a long-jawed characin than it does in a short-jawed form. The area for muscle attachment should consequently be greater in the former. But in the Serrasalminae the length of the lower jaw is correlated with food habits, those species with a long jaw being flesh eaters (notably the "piranhas," genus *Serrasalmus)* whereas the short-jawed forms are herbivorous. One exception to this correlation seems to exist, namely the aberrant, long-jawed form, *Catoprion mento,* which, so far as I can determine from the four stomachs examined, eats only fish scales.

The relationship between dentition and food is more obvious. The "piranhas" have a single set of shearing teeth on the premaxillary (fig. 2d) and on the mandible; in some, teeth are also developed on the palatines. In the herbivorous forms there are two rows of teeth on the premaxillary, those of the anterior row being in part conical and those of the rear one being molariform; both rows seem to bite against the flesh of the lower lip. The single main row of teeth in the lower jaw shears chiefly against the inner face of the molariform teeth above. In *Catoprion* both jaws have scattered, tuberculate teeth.

It is not easy to visualize the derivation of the tooth patterns of *Ser-*

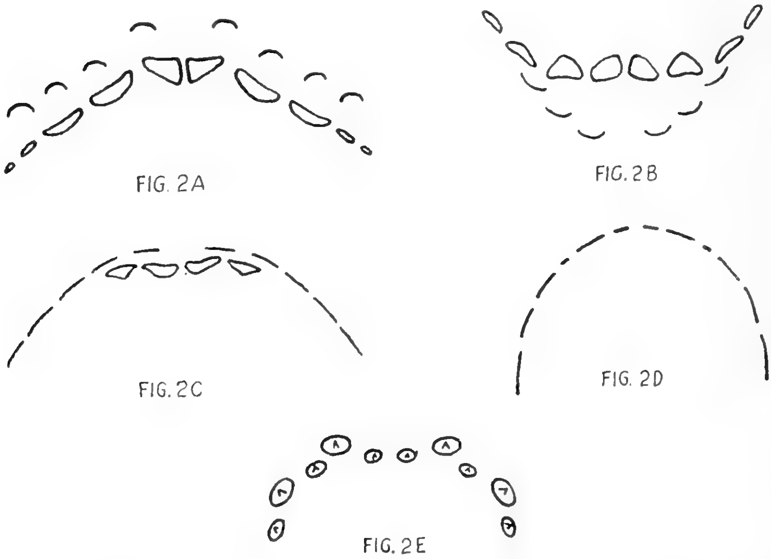
FIG. 2A

FIG. 2B

FIG. 2C

FIG. 2D

FIG. 2E

Figure 2. Diagrammatic representation of the dentition of the upper jaw. Open lines depict conical or shearing teeth. Empty closed lines indicate more or less molariform teeth with the shearing surface the inner rim. Carets within closed lines denote tuberculate teeth. All figures are drawn looking up from below. a. *Astyanax bimaculatus* (a tetragonopterine characin); b. *Myleus rhomboidalis;* c. *Mylesinus schomburgkii;* d. *Serrasalmus rhombeus;* e. *Catoprion mento.*

rasalmus, Catoprion, and the herbivorous Serrasalminae from one another, though all are undoubtedly representatives of a single phylogenetic stock. It may be speculated that the herbivorous pattern was derived from the tetragonopterine form (fig. 2a). The front four (probably six) teeth of the outer row appear to have been derived from the tetragonopterine outer row; likewise the four molariform teeth of the inner row seem to be traceable to the tetragonopterine inner row; which row the two outermost teeth on either side came from is not clear. The maxillary teeth, usually present in the Tetragonopterinae, are present among the Serrasalminae only in some species of *Colossoma.* For the "piranhas," it is tempting to suggest that the single row of six teeth on one side of the upper jaw is made up of the seven teeth of the two rows of the herbivores pressed into a single row, with one tooth dropping out (fig. 2d). This seems a logical hypothesis, but I can find nothing for or against it, as there is no tooth pattern intermediate between *Pygopristis* and the herbivores. *Catoprion* again is completely aberrant, showing little affinity for either group (fig. 2e).

In the lower jaw the number of teeth is more variable, and there may be a pair of conical teeth behind the main row at the symphysis. *Pygopristis* and *Serrasalmus* lack conical teeth but usually have seven teeth on one side in front; in the herbivores there are usually five in the front row below on each side plus a conical tooth, but *Mylesinus* and *Colossoma* may have as many as twelve.

Of the taxonomic characters correlated with the deep bodies of the Serrasalminae, the scutation of the midventral line is perhaps the most obvious. A spiniferous midventral surface has arisen several times among the South American soft-rayed fresh-water fishes. It is found in the clupeid *Pristigaster* and in the curimatine characin *Psectrogaster.* Both of these are deep-bodied fishes.

It seems fairly certain that the ventral scutes have arisen from scales. In some species, as in *Colossoma nigripinnis,* which has large scales and small scutes, the number of scutes about equals the number of transverse scale rows. In other genera, however, the scutes are larger and the scales smaller. In some, although the scutes between the ventral and the anal are well developed, those before the pelvics either become gradually indistinguishable forwards (as in *Utiaritichthys)* or are totally wanting (as in *Acnodon).* Whether this absence of scutes forward is primitive or secondary I do not know.

A predorsal spine is found in three subfamilies of South American characins, all deep-bodied, namely the Stethaprioninae, Prochilodinae, and Serrasalminae. The presence of both abdominal scutes and a predorsal spine seems to be most easily explained on the grounds that these are defense structures. It would appear that in a deep-bodied, relatively slow-moving fish, spines at the most dorsal and most ventral parts of the body might mean the difference between fitting and not fitting into the gape of a would-be predator.

The length of the dorsal fin likewise seems to be correlated with the depth of body. The usual number of dorsal rays in characins is 10 to 12. There are several subfamilies of characins that exceed this number, however: Crenuchinae and Serrasalminae in South America; Ichthyoborinae (in part), Distichodontinae (in part), and Citharininae in Africa (according to Boulenger's 1909 classification). Most of these are deep-bodied.

However, a much better correlation between dorsal length and depth of body is to be found within the Serrasalminae. In this subfamily the usual number of dorsal rays is 16 to 18. There is one particularly deep-bodied genus, however, *Myleus,* in which the number of dorsal rays is always more than 20. In another especially deep-bodied genus, *Metynnis,* the rayed dorsal retains its normal length, but the adipose is extremely long. The best corre-

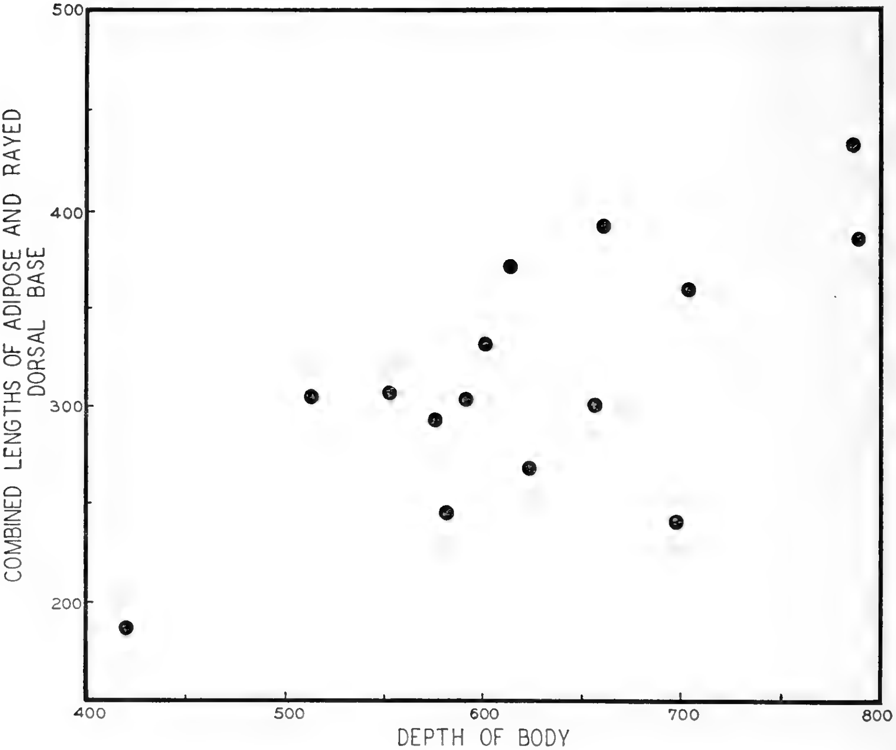

Figure 3. Correlation between depth of body and combined lengths of rayed and adipose dorsals in fifteen species of Serrasalminae. Data from table 1. All measurements expressed as thousandths of standard length.

lation between the depth of the body and the length of dorsal in this subfamily is not to be obtained by plotting the body depth against the length of the rayed dorsal or of the adipose alone, but by correlating depth with the combined lengths of the rayed dorsal and adipose bases (table 1 and fig. 3). This suggests that the adipose not only supplements the rayed dorsal, but that it performs more or less the same function. It is interesting to note in this connection that in some species of two serrasalmine genera, *Serrasalmus* and *Colossoma,* the adipose becomes rayed in the adult.

The phylogenetic diagram here presented (fig. 4) is based chiefly on the characters discussed above. Besides these I know of only two characters of minor importance for serrasalmine generic classification. These are the number of branchiostegal rays and the number of anal rays.

As the diagram is intended to suggest, I believe that there have been about five major lines of specialization in the Serrasalminae. In *Serrasalmus, Pygopristis,* and *Catoprion* the teeth have undergone two different proc-

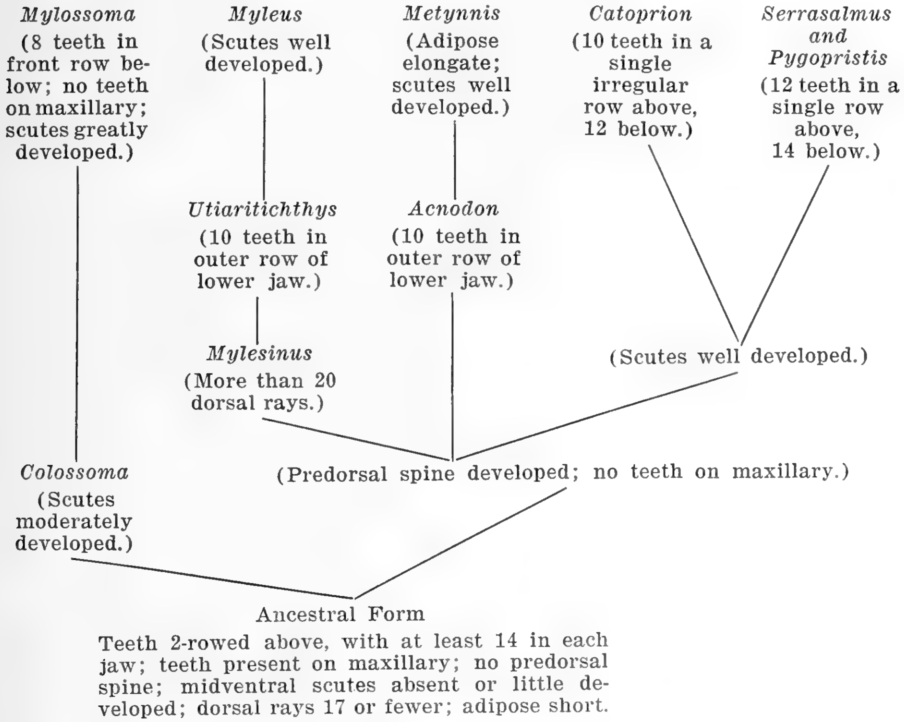

Figure 4. Suggested phylogeny of the genera of Serrasalminae. Characters thought to be present in the serrasalmine ancestor are given at the bottom. Specializations away from the ancestral form are in parentheses. Each genus possesses all those specializations given in the parentheses below it in its own lineage.

esses of modification from the ancestral type; in *Mylossoma* the scutation reaches its highest development in the subfamily; in *Myleus* the dorsal fin has become lengthened; and in *Metynnis* the adipose is longer than in any other serrasalmine genus.

KEY TO THE GENERA OF SERRASALMINAE

1. Teeth in a double row in the upper jaw, 14 in all, the posterior row composed of four molariform teeth (figs. 2b and c); lower jaw short, more or less included 2

— Teeth not in a double row above (figs. 2d and e); lower jaw protruding.... 8

2.(1) Predorsal spine absent. Dorsal with 19 or fewer rays; adipose short-based 3

— Predorsal spine present 4

3.(2) Anal short, with 28 or fewer rays; 5 branchiostegal rays; 6 or more teeth on either side of the lower jaw .... I. *Colossoma*

— Anal long, with 36 or more rays; 4 branchiostegal rays; 4 teeth on either side of lower jaw .... II. *Mylossoma*

4.(2) Seven to 12 teeth on either side of lower jaw. Adipose short-based; dorsal with 21 or 22 rays .... III. *Mylesinus*

— Four to 6 teeth in the main row on either side of lower jaw 5

5.(4) Anal falcate, bilobed, or trilobed, the posterior rays contained 3 or more times in the longest anterior rays; adipose fin short or moderate, its base less than half the length of the base of the rayed dorsal 6

— Anal not falcate and without conspicuous lobes, the last rays more than half as high as longest ray; adipose long, more than half the length of the rayed dorsal base .... VII. *Metynnis*

6.(5) At least a few scutes developed ahead of the ventral fins on the midline of the abdomen; dorsal with 20 or more rays 7

— Preventral scutes completely lacking on the abdomen; 15-19 dorsal rays. No conical teeth behind central teeth of the main row below.... VI. *Acnodon*

7.(6) Only 9 or 10 scutes developed ahead of the ventral bases on the abdominal midline .... IV. *Utiaritichthys*

— Usually 20 or more scutes developed ahead of the ventral bases on the midline of the abdomen .... V. *Myleus*

8.(1) Teeth in jaws tuberculate, widely separated, 10 in the upper jaw (fig. 2e) and 12 in the lower; first dorsal rays elongate, the fin falcate .... VIII. *Catoprion*

— Teeth in jaws close-set, shearing, 12 in the upper (fig. 2d) and usually 14 in the lower; first dorsal rays not elongate, the fin not falcate 9

9.(8) Most of the teeth with 5 (or more) lobes, denticulate .... IX. *Pygopristis*

— Teeth trilobed (or simple) .... X. *Serrasalmus*

I. **Colossoma** Eigenmann

Piarctus Eigenmann and Allen, 1942, p. 247 (*lapsus calami* for *Piaractus* Eigenmann). New synonymy, to be added to Norman's generic synonymy.

In several characters (fig. 4) *Colossoma* seems to be the most primitive genus of the Serrasalminae. In other respects, as in the rayed adipose and the more or less ctenoid scales of certain of its species, it is extremely specialized. In regard to still other characters—the comparatively short anal, the presence of 5 branchiostegal rays, and the high number of gill rakers—*Colossoma* may be either primitive or aberrant. In any event, the genus has no close relatives among the Serrasalminae or elsewhere.

Teeth 5+2/6—8+1; upper part of maxillary with teeth in *C. bidens.* Branchiostegal rays 5-5; gill rakers usually numerous, 15-46 below; exposed suborbitals all of about equal depth. Abdominal scutes numerous, 45-69, scales large to small, 60-120. Predorsal spine absent; rayed dorsal with 14-19 rays; adipose short, rayed in adults except in *C. bidens* and *C. oculus;* anal short, with 28 or fewer rays. (Most of these counts are from Norman, 1929.)

Piaractus Eigenmann is often considered a separate genus, but *C. bidens* seems too nearly intermediate between *Colossoma* and *Piaractus* to make this procedure advisable.

Five to seven known species, revised by Norman, 1929. As noted by Eigenmann and Allen (1942, p. 248), *Colossoma* is neuter, and the adjectival specific names in the genus must be given neuter endings.

To the species cited by Norman, add *Colossoma canterai* (Devincenzi) in Devincenzi and Teague, 1942, p. 74, 1 fig. (Río Uruguay). This species is closely related to *C. mitrei.*

II. **Mylossoma** Eigenmann

This genus, although agreeing with *Colossoma* in the absence of a predorsal spine, differs strikingly in several other respects. The individual preventral scutes are the most highly developed of any genus in the Serrasalminae; the teeth in the lower jaw are reduced to 4 on a side; and the body is extremely deep and the anal long. Finally, the air bladder tapers into a cone-shaped projection which extends posteriorly over the base of the interhaemals; in this, *Mylossoma* agrees with the deep-bodied genus *Metynnis,* though it is highly probable that the character has been evolved independently in the two genera.

Teeth 5+2/4+1; no teeth on maxillary. Branchiostegal rays 4-4; gill rakers about 12 below in *M. duriventre;* exposed suborbitals of approximately equal width (fig. 5a). Abdominal scutation greatly projecting, 34-53; scales small. Predorsal spine absent; rayed dorsal with 14-19 rays; adipose short, never rayed; anal count 29-42. (Most of these counts are from Norman, 1929.)

Five known species, revised by Norman (1929). To the synonymy of *M. duriventre* given by Norman (1929, p. 813) add *Mylossoma argenteum* Ahl, 1929, p. 273 (Amazon River). *Mylossoma* is also a neuter name, and its adjectival specific names must be made to agree.

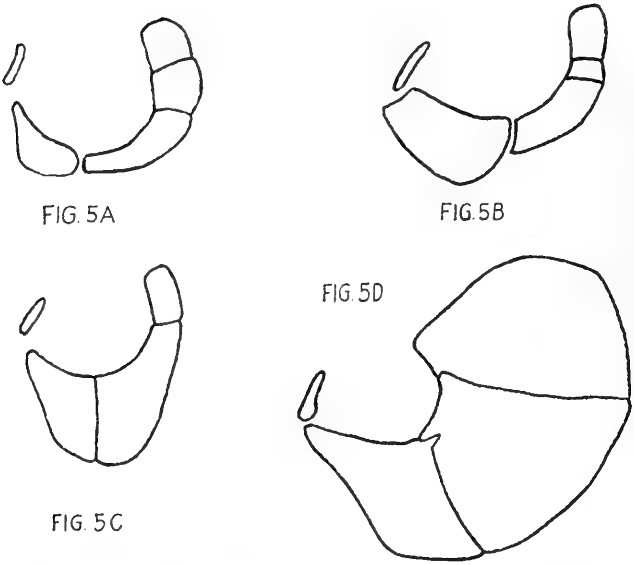

Figure 5. Suborbital bones of various Serrasalminae. a. *Mylossoma duriventre;* b. *Acnodon normani;* c. *Catoprion mento;* d. *Serrasalmus nattereri.* Many specimens of various species of the subfamily may have four exposed suborbital bones on one cheek and three on the other.

III. **Mylesinus** Valenciennes

This genus is easily distinguished from *Myleus,* which it resembles superficially, by the shape of the teeth, by the larger number of teeth in the lower jaw, and by the complete absence of preventral scutes on the abdomen.

There are apparently only three records of this monotypic genus. The original description by Valenciennes (1849, p. 234, pl. 644) was based on a head and a figure of the body of a specimen presumably from the Essequibo River in British Guiana. According to Norman (1929, p. 807), the British Museum is in possession of a badly preserved skin from Demerara, British Guiana. Finally Kner (1859, p. 32, pl. 3, fig. 7) recorded the fish from the Rio Vaupés, a tributary of the Rio Negro in Brazil. For some reason I do not understand, Norman has considered Kner's record, with his redescription and plate, as a misidentification for *Myleus setiger.*

Teeth 5+2/7—12+1; no teeth on maxillary. Branchiostegal rays 4-5; gill rakers 13 below; exposed suborbitals of approximately equal width. Abdominal scutation weak, about 12 small preventral plus 17 postventral scutes; scales small. Predorsal spine present; rayed dorsal with 22 rays; adipose short, not rayed; anal count 34.

1. **Mylesinus schomburgkii** Valenciennes

Plate 1; figure 2c

Since the original description of this species is based in part on a drawing, it is impossible, at least until topotypic material is collected, to know whether the specimens described by Kner, or the one at hand, actually represent *M. schomburgkii.*

The single specimen before me, C.A.S. 20221, is 205 mm. in standard length and was collected by Dr. Carl Ternetz at Mosondó on the Maranhão, a tributary of the Upper Tocantins in the State of Goiaz, Brazil, on Oct. 2, 1923.

Depth 1.9, head 4.0 in the standard length. No teeth on maxillary. Five teeth on each side in the outer row above, gradually becoming smaller from the center toward the sides; each tooth flattened from front to rear, with small lateral lobes and a large, rounded median lobe (well figured in Cuvier and Valenciennes, 1849, pl. 644). Close behind the central teeth of the outer series of each side of the upper jaw lie two more or less molariform teeth (fig. 2c) with highly raised posterior rims; these posterior teeth are much wider than thick. Lower jaw with 8 or 9 teeth on one side in an outer series, similar in shape to the outer teeth of the upper jaw. A small, backwardly projecting, conical tooth behind the central tooth of the outer series below on each side.

Maxillary rather short and broad, truncate below, independently movable. Branchiostegal rays 4-5. Gill rakers short and stiff, 13 below. The second suborbital (the first suborbital or lacrymal is not exposed) deeper than the third: the width of the latter contained 9.3 times in the head. Lower jaw relatively long, its length from front of symphysis to articulation with skull 2.9 in head.

Scales cycloid, about 38/82/32. Pectoral rays 17; ventrals 8-8; anal 34; dorsal 22; caudal with 17 branched rays. Adipose base 7, dorsal-adipose distance 2.3 in dorsal base. Anal bilobed, commencing behind level of base of last dorsal ray, with its basal third covered with a heavy sheath of scales similar to those on body. Dorsal more or less falcate, the first rays long but not filamentous.

Predorsal spine well developed. Predorsal midline naked for a short distance ahead of predorsal spine, scaled from there to tip of supraoccipital. Twelve weak scutes before ventral bases, followed by 9 stronger, these in turn followed by 8 pairs of scutes surrounding the forward part of the anus. Intestine and anus of a wide diameter; stomach elongate U-shaped, full of plant remains.

Border of caudal, dorsal, and anal dusky; body plain golden, darker above.

TABLE 2

Ranges of counts for the species of *Utiaritichthys* and *Myleus*. Synonyms in parentheses. Ranges of counts are not necessarily based on total number of specimens examined. The number of pectoral rays seems to have no systematic significance.

	Author	No. of specimens examined	Tooth formula	No. of gill rakers above and below	Total No. of dorsal rays	Total No. of anal rays	No. of ventral rays	No. of scutes		Scale formula
								Pre-ventral + post-ventral	Total	
Utiaritichthys sennae-bragai	Miranda Ribeiro	4	5+2/5+1	13/14	20	36	....	9+16	25	31/86/26
	Gosline	1	5+2/5+1	x/16	22	33	8-9	10+x	....	x/100/x
Myleus micans	Lütken	2	5+2/6+1	....	27-28	36-39	8	....	52-53	35/100-115/30-33
	Eigenmann, 1915	2	....	....	26	37-38	....	....	51-54	....
	Norman	1	....	x/16	25	38	....	32+18-22	50-54	....
M. altipinnis	Valenciennes	1	....	....	24	38	8	....	....	....
M. setiger	Müller & Troschel	1(?)	5+2/5+0	....	22	36-39	9	....	39	....
	Norman	2	x+x/x+1	x/15-16	22-25	34-37	....	21-23+15-16	....	....
	Gosline	5	5+2/5+0-1	8-11/13-15	20-23	33-34	8	20-25+12-18	32-40	38-44/74-100/30-43
(doidyxodon)	Valenciennes	1	2(?)+2/x+1	....	22	35	....	....	....	....
M. knerii	Steindachner	1	x+2/5+1	....	27	34	8	....	36-37	38/70/28
M. pacu	Schomburgk	2	4-5+2/4-5+1	....	22	43	9	....	....	....
	Eig., 1912 & 1915	4	5+2/5+1	....	23-25	36-38	....	....	35	43/95-110/34
(divaricatus)	Valenciennes	1	x+2/x+1	....	23	33	....	....	....	....
(trilobatus)	Valenciennes	2	5+2/x+1	....	23	39	8	....	35	x/90/x
(unilobatus)	Valenciennes	1	x+x/5+1	....	21	36	9	18+17	35	....
M. torquatus	Kner	?	5+2/4+1	....	25	34-36	8	....	39-42	....
	Gosline	11	5+2/5+1	7-11/15-16	24-27	32-36	8	24-30+13-18	37-46	....
M. ternetzi	Norman	2	5+2/x+0	x/10	24-26	30-33	....	23-26+14-17	....	....
M. schomburgkii	Jardine	1(?)	....	....	25	39	8	....	....	....
	Eigenmann, 1915	9	....	....	25-26	34-36	....	....	33-36	....
	Gosline	1	5+2/5+1	13/15	24	35	7-8	....	34	35/80/31
(palometa)	Valenciennes		....	....	....	....	....	....	....	....
M. rhomboidalis	Cuvier	?	....	....	22-24	32-36	8-9	....	....	x/125/x
	Norman	8	....	x/14-17	24-25	35-37	....	22-28+13-15	....	....

	Author	No. of specimens examined	Tooth formula	No. of gill rakers above and below	Total No. of dorsal rays	Total No. of anal rays	No. of ventral rays	No. of scutes		Scale formula
								Pre-ventral + post-ventral	Total	
	Gosline	2	5+2/5+1	5/14	23	35	7-8	26+15-16	41-42	....
(parma)	Günther	2	5+2/5+1	....	23-24	38	7-8	....	36	....
(discoideus)	Kner	?	5+2/5+1	....	23	34	8	....	33	....
M. latus	Schomburgk	...	....	....	22	37	8	....	....	....
	Müller & Troschel	1	5+2/5+1	....	23	34-37	9	....	38	....
	Eigenmann, 1912	21	....	....	23-24	35-36	....	....	37-41	....
	Norman	2	....	x/15	24-25	34-35	....	23-25+12-14	....	....
M. rubripinnis	Müller & Troschel	1	5+2/5+1	....	26	42	7	....	41	....
	Günther	3	....	....	26-27	38-42	7-8	....	33-36(?)	....
	Eigenmann, 1912	17	....	....	26-28	36-44	....	33-41+ 4- 8	....	x/88/x
	Norman	4	....	x/16-17	27-28	39-43	....	29-32+17-19	....	....
	Gosline	1	....	16/16	27	45	....	26+12	38	....
M. asterias	Müller & Troschel	1(?)	5+2/5+1	....	29-31	40	8	....	43-45	....
	Günther	4	....	....	29-31	39-40	8	....	....	....
	Eigenmann, 1912	2	....	....	27	35-39	....	....	48-52	x/87-89/x
	Norman	10	....	x/14-16	27-32	37-41	....	28+10	38	....
(ellipticus)	Günther	2	5+2/5+1	....	27-29	39	7	....	41-51	....
(schulzei)	Ahl	1	....	....	29	39	....	....	46	....
M. maculatus	A. Campos	1	x+x/x+1	....	28	36	....	....	33	....
	Gosline	6	5+2/5+1	6-14/13-17	(21) 24-26	35-38	6-7	30-33+12-20	43-51	....
(lobatus)	Valenciennes	3	....	....	23	33	....	....	....	....
M. gurupyensis	Steindachner	2	x+x/3(?)+1	....	28	32-34	6	24+12-13	36-37	42/90/42
	Gosline	7	....	....	25-27	32-38	6-7	24-31+16-19	41-48	....
M. tieté	Eig. & Norris	1	x+x/6+1	....	27	37	....	....	46	....
	Eig. & Kennedy	1	....	....	27	35	....	....	44	x/80/x
(levis)	Eig. & McAtee	1	5+2/5+1	....	27	36	....	....	45	x/112/x
	Eigenmann, 1915	3	....	....	27-31	35-36	....	....	40-53	....
	Norman	3	....	x/14-16	27-28	33-36	....	26-29+16-19	....	....

IV. **Utiaritichthys** A. de Miranda Ribeiro

Utiaritichthys A. de Miranda Ribeiro, 1937, p. 58 (genotype by monotypy *Utiaritichthys sennae-bragai).*

Utiaritichlys A. de Miranda Ribeiro, 1937, p. 58 (misprint for *Utiaritichthys).*

The single known species of this genus, *U. sennae-bragai,* was originally described from four specimens, the largest 380 mm., from above the Utiarity Falls on the Rio Papagaio, in the upper Rio Tapajós basin, State of Mato Grosso, Brazil.

Teeth 5+2/5+1; no teeth on maxillary. Branchiostegal rays 4-4; gill rakers 15 below; exposed suborbitals of approximately equal width. Abdominal scutation weak, about 9-10 preventral and 16 postventral scutes; scales small. Predorsal spine present; rayed dorsal with 20-22 rays; adipose short, not rayed; anal count 33-36.

1. **Utiaritichthys sennae-bragai** A. de Miranda Ribeiro

Table 2, plate 2

A specimen at hand, C.A.S. 20222, 168 mm. in standard length, collected in the Rio Tocantins at Marabá, State of Pará, Brazil, April 24, 1924, agrees well with Miranda Ribeiro's description, even though his specimens were taken in Mato Grosso. In general characteristics, this specimen resembles the genus *Myleus,* to which it appears closely related, apparently differing from that genus only in having the scutation little developed forward of the ventrals. The front teeth of the outer row above are somewhat incisiform, but taper to a median point; they are slightly separated from the teeth of the second row, which have the rims more highly raised than is usual in *Myleus.*

The conical teeth in the lower jaw are very small.

V. **Myleus** Müller and Troschel

Table 2

Myleus as here dealt with differs rather widely from Norman's (1929) conception of the genus. In fact, since 1845, when Müller and Troschel proposed the genus, no two authors have agreed on the generic classification of the group to which it belongs. *Myleus,* as I understand it, comprises all those species of serrasalmine fishes with 20 or more dorsal rays and with at least 2/3 of the abdomen with scutes along the midline. So constituted it includes *Myleus, Myloplus,* and *Paramyloplus* of Norman. These three genera Norman separated as follows (1929, p. 782)

"Conical mandibulary teeth present . . .

> Anterior teeth of outer series of praemaxillary compressed, incisor-like, in contact with those of inner series....................8. *Myleus*
>
> Anterior teeth of outer series of praemaxillary with an oblique cutting edge, not greatly compressed, generally more or less separated from those of inner series....................9. *Myloplus*

No conical mandibulary teeth....................10. *Paramyloplus*"

As to the presence of conical mandibulary teeth in *Myleus* and *Myloplus*, the type of *Myleus setiger* is described as lacking them. Furthermore, of three Carnegie Museum specimens which Eigenmann has identified as *Myleus pacu*, C.M. No. 5749 has a pair of conical teeth, No. 5750 has a single one, and No. 5751 has none.

Norman's wording of the distinction between *Myloplus* and *Myleus* is not entirely clear to me. Nevertheless, that all degrees of intergradation between the two tooth types described by him occur may be verified by a simple examination of Eigenmann's tooth drawings (1915, pp. 269 and 270, figs. 12-14). I have seen the tooth sets from which the drawings were made, and they are as shown. Still another type of dentition found in this genus is shown in figure 6, and further discussion of the subject is given below.

Eigenmann (1915, p. 262) has differentiated *Myloplus* from *Myleus* chiefly on the presence of prolonged, filiform dorsal rays in the adult males of *Myleus* and their absence in *Myloplus*. But it appears that some, perhaps all, adult males of *Myloplus* have prolonged, filiform dorsal rays.

No other characters have been used for separating *Myleus, Myloplus,* and *Paramyloplus,* and I can find none.

Specific classification within the genus is likewise difficult. The problems presented are partly zoological, partly nomenclatorial. Of the 27 described species which belong to the genus, 19 were described before 1865. The type of only *M. levis* is in this country. Many of the older descriptions were based on incomplete or stuffed specimens. Furthermore, considerable confusion has arisen in the literature because of the sexual differentiation within the genus. Females have a falcate anal, whereas in adult males the anal is bilobed. Furthermore, adult males of at least some species have filamentous dorsal rays. Thus the males and females of the same species have often been described under different names. On the other hand, Kner (1859), who realized that there was sexual differentiation, went too far in synonymizing names, and in several places combined under one name males and females of two different species; I find nothing to support Kner's contention that there is sexual differentiation in dentition.

Zoologically, the species present several further problems. Most of the forms grow to large size, and the measurement ratios change considerably during growth. Of meristic characters, the scale count is extremely unreliable because the scales are small and in rather irregular rows. Fin ray and scute counts are valuable, but show considerable variation; the variability within any species is partly individual and partly geographical, and there are insufficient specimens available in museums to disentangle these two sources of variation or to determine their limits.

The species of the major part of the genus *Myleus* have never been revised. Under the circumstances, the synopsis of species presented below cannot hope to give more than direction to future work. So far as known, specimens of all ten or so species represented in American museums have been examined. These specimens have been used as a yardstick for evaluating the literature.

There seem to be three main categories of tooth types represented in this genus:

I. The front three teeth of the outer row above on each side are considerably compressed from front to back (fig. 6b) and expanded laterally so as to become somewhat spoon-shaped (fig. 6a); these teeth are in contact or slightly overlap one another at the sides. The molar teeth of the second row above are appressed against the inner bases of the first two of the teeth of the row in front and are considerably wider than deep. The teeth of the outer row of the lower jaw form approximately a semicircle. The conical teeth of the second row below are very small.

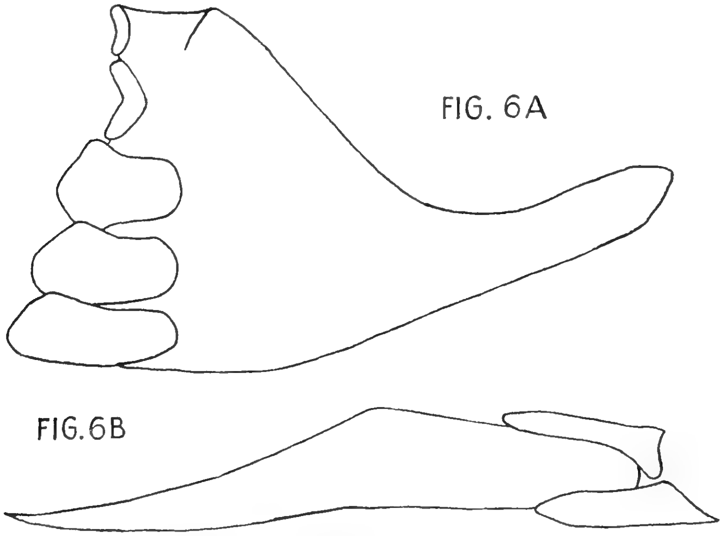

Figure 6. Right premaxillary of *Myleus setiger* from the Rio Tocantins. a. View about half way between front and lateral; b. Sagittal view.

II. This is the tooth type illustrated by Eigenmann, 1915 (p. 270, fig. 13). The chief differences between this and type I are that the first two teeth on each side in the outer row above are less flattened from front to rear and are separated from one another, and the molariform teeth of the second row are little or not appressed against the teeth of the outer row.

III. Eigenmann's figure 12 (1915, p. 269) illustrates this type. The front teeth of the outer row are more or less conical. The molar teeth behind are as deep as, or deeper than, broad. The front four teeth below form an almost straight line across the front of the lower jaw. Conical teeth behind are usually present, sometimes absent. Most of the species of the genus have dentition of type III, with the molar teeth often farther removed from the front teeth of the upper jaw than shown in Eigenmann's figure 12.

Eigenmann infers that type III may change to type II with increase in age (1915, figs. 12 and 13). He may be correct in this, though I know of no evidence for it. On the other hand, *M. setiger,* which I believe belongs to type I, is generally synonymized with *M. pacu,* which has type II dentition. Thus the three tooth types described above, though they may be good as specific characters, grade into one another and are difficult to use. Furthermore, no supplementary characters which may be correlated with the three tooth types were found. Nevertheless, I suggest, at least as a working hypothesis, that Eigenmann's figures 12 and 13 of *Myleus pacu* actually represent two different species and that *Myleus setiger* is a third species with tooth type I. A graded size series of *Myleus pacu* might quickly settle this question, but there is no such series.

Teeth 5+2/5—6+0—1; no teeth on maxillary. Branchiostegal rays 4-4; gill rakers 6—14/13—17; first exposed suborbital somewhat deeper than the others. Abdominal scutes moderately developed, 33-54; scales small. Predorsal spine present; rayed dorsal with 21-31 rays; adipose short, not rayed; anal count 30-44.

The distribution of the genus *Myleus* is from the Guianas to La Plata and from the eastern base of the Andes to the Rio São Francisco. The Paraguayan form seems to be slightly different from its Amazonian relatives, and only one species, *M. setiger,* is tentatively considered to inhabit both the Amazon basin and Guiana. As with other groups of fishes, the representation of this genus in the Orinoco is unknown.

To the synonymy of *Myleus* add *Tomète* Amaral Campos, 1944, p. 211 (emendation of *Tometes* Valenciennes, in Cuvier and Valenciennes, 1849, p. 225; *Tomète,* attributed by Amaral Campos to Cuvier and Valenciennes, was used by Valenciennes only as a French common name for a fish of the genus *Tometes).*

PRELIMINARY KEY TO THE SPECIES OF MYLEUS

1\. Scutes on the ventral midline 50 or more; teeth on the outer row of the lower jaw 10 to 12. Species of the São Francisco basin.......... 2

— Scutes usually fewer than 50; teeth of the outer row of the lower jaw never more than 10. Species not found in the Rio São Francisco basin.......... 3

2.(1) Depth of body 1½ in the length; posterior dorsal rays not longer than those of middle of fin (Norman).......... 1. *M. micans*

— Depth of body twice in the length; posterior dorsal rays rather higher than those in middle of fin (Norman).......... 2. *M. altipinnis*

3.(1) Front 6 teeth of outer row above incisiform, more or less spatulate, the first and second teeth from the front on either side in contact or slightly overlapping one another (fig. 6a); molar teeth of inner row appressed against bases of teeth of outer row (fig. 6b). Dorsal rays of adult males prolonged as filaments 4

— Front 6 teeth of outer row above more or less conical, well separated from one another; molar teeth of inner row of upper jaw never flattened against the teeth of the outer row.......... 5

4.(3) Dorsal rays 22-25. British Guiana and Amazon basin.......... 3. *M. setiger*

— Dorsal rays 27. French and Dutch Guiana.......... 4. *M. knerii*

5.(3) The two teeth of the inner row of the upper jaw adjacent to the teeth of the outer row, the individual teeth broader (from side to side) than deep (from front to back). British and French Guiana.......... 5. *M. pacu*

— The two teeth of the inner row of the upper jaw separated from the outer row, the individual teeth deeper than broad.......... 6

6.(5) Caudal with a distinctly delimited black margin. Dorsal rays 24-27; dorsal origin nearer end of vertebral column than tip of snout. Central Amazon basin.......... 6. *M. torquatus*

— Caudal sometimes with a dusky border, but never with a distinctly delimited marginal black band.......... 7

7.(6) Species with a single, large, well-defined black blotch on side.......... 8

— Species without a single well-defined dark blotch on sides.......... 9

8.(7) Black blotch extending from anal fin forward onto body, not reaching as high as lateral line; no conical mandibular teeth. French Guiana.......... 7. *M. ternetzi*

— Black blotch extending downwards and backwards across lateral line from below dorsal to above depressed ventral; conical teeth present. Amazon basin.......... 8. *M. schomburgkii*

9.(7) Dorsal relatively short and high, the height of its anterior rays longer than the dorsal base; distance from base of last dorsal ray to end of vertebral column about equal to the dorsal base. Dorsal origin considerably nearer snout than end of vertebral column, its rays 22-25; caudal peduncle appreciably deeper than long; adipose fin relatively large, its base contained about 5 times in the dorsal base.......... 10

— Dorsal relatively long and low, the anterior rays (exclusive of the dorsal filaments of adult males) less than length of dorsal base; distance from base of last dorsal ray to end of vertebral column less than length of dorsal base 11

10.(9) Distal part of the anterior anal rays black (Norman). Amazon basin .... 9. *M. rhomboidalis*

— Anterior anal rays yellowish white (Norman). Guiana .... 10. *M. latus*

11.(9) Middorsal profile of head concave over the eyes; dorsal somewhat falcate, the last rays about 2.7-3.0 in the length of the second which is nearly equal to the head length; anal rays 36-45. Dorsal adipose distance contained 3½-4½ in the dorsal base. British Guiana .... 11. *M. rubripinnis*

— Middorsal profile of head flattish or evenly convex over the eyes; except in adult males with dorsal filaments, the dorsal fin has a rounded border and the length of the last dorsal rays is contained about 2.1-2.2 in the length of the second, which is far shorter than the head; anal rays 32-41 12

12.(11) Interorbital width about 2 in head 13

— Interorbital width contained fewer than 2 times in the head. Paraguay river system .... 15. *M. tieté*

13.(12) Ventral rays 8 (7?); sides with small orange spots; dorsal rays 27-31, not filamentous in adult males. British Guiana .... 12. *M. asterias*

— Ventral rays 7 or 6; sides sometimes with irregular dark blotches, but not with bright orange spots; dorsal rays (21) 24-28 14

14.(13) Dorsal rays filamentous in the adult male. Amazon basin .... 13. *M. maculatus*

— Dorsal rays without filaments in the adult male. Amazon basin .... 14. *M. gurupyensis*

1. **Myleus micans** (Lütken)

Myletes (Tometes) micans LÜTKEN, 1874, p. 137 (Rio das Velhas and its tributary, the Rio Taquoaraçú, in the vicinity of Lagoa Santa, State of Minas Gerais, Brazil); LÜTKEN, 1875, p. 241, figs. on p. 243 (on the types).

Myloplus micans, EIGENMANN, 1915, p. 270, fig. 14 (Cidade do Barra, at the junction of the Rio Grande and the Rio São Francisco; and Santa Rita on the Rio Preto, a tributary of the Rio Grande, State of Minas Gerais, Brazil).

Myleus micans, NORMAN, 1929, p. 822 (Rio das Velhas, State of Minas Gerais, Brazil).

This species (and the following?) possesses two characters which appear to be primitive for the genus. One is the large number of abdominal scutes, totaling 50-54, and, at least occasionally, the presence of more than 5 teeth on one side of the lower jaw in the outer row. Also, the front teeth of the lower jaw have broader lateral lobes than is usual in the genus; the teeth of the upper jaw conform rather closely to type II described above. The general appearance of the head of the fish is distinctively sheep-like. This species and *M. altipinnis* are the only representatives of *Myleus* in the São Francisco basin.

2. **Myleus altipinnis** (Valenciennes)

Tometes altipinnis VALENCIENNES, in Cuvier and Valenciennes, 1849, p. 230, pl. 643 (Rio São Francisco, Brazil).

Myletes altipinnis, GÜNTHER, p. 377 (Rio Cipo, a tributary of the Rio das Velhas, State of Minas Gerais, Brazil).

Myleus altipinnis, NORMAN, 1929, p. 823 (on Günther's specimen).

This form is generally considered to be very close to, if not identical with, the preceding species. The characters used in the key to differentiate *M. altipinnis* from *M. micans* are those given by Norman (1929, p. 821).

3. **Myleus setiger** Müller and Troschel

Figure 6

Myleus setiger MÜLLER AND TROSCHEL, 1845, pp. 24 and 39, pl. 11 (Essequibo River, British Guiana; Surinam); Norman, 1929, p. 821 (loc. ?).

Myletes doidyxodon VALENCIENNES, in Cuvier and Valenciennes, 1849, p. 222 (Amazon); Castelnau, 1855, p. 67, pl. 34, fig. 1 (Amazon).

Myletes setiger, KNER, 1859, in part, p. 27, pl. 2, figs. 6 and 6a (loc. ?).

This species is generally considered to be the young of *M. pacu,* which may be true. Provisionally I prefer to identify Müller and Troschel's species with some Rio Tocantins specimens which have the dentition shown in figure 6. It may prove, however, that these specimens are not *M. setiger,* in which case they will have to go by Valenciennes' name, *M. doidyxodon.*

Myleus setiger, as the species is here interpreted, differs from *M. pacu* in the dentition, in having the dorsal in the females more falcate, and in the extremely long dorsal filaments (Kner, 1859, pl. 2, fig. 6) in males as small as 150 mm. The largest specimen of this species known is 12 inches long. The range is tentatively given as the Amazons and Guiana.

Conical teeth in the lower jaw seem to be small or absent depending upon the specimen.

4. **Myleus knerii** (Steindachner)

Myletes knerii STEINDACHNER, 1881, p. 127, pl. 7, fig. 2 (Maroni River, Guiana).

This species is very close to *M. setiger,* differing in the higher dorsal ray count.

5. **Myleus pacu** (Schomburgk)

Myletes pacu SCHOMBURGK, 1841, p. 236, pls. 20 and 21 (British Guiana).

?*Myletes divaricatus* VALENCIENNES, in Cuvier and Valenciennes, 1849, p. 215 (Essequibo River, British Guiana).

Tometes trilobatus VALENCIENNES, in Cuvier and Valenciennes, 1849, p. 226 (Cayenne).

Tometes unilobatus VALENCIENNES, in Cuvier and Valenciennes, 1849, p. 228 (Cayenne).

Myleus pacu, EIGENMANN, 1912, p. 393, pl. 59, figs. 5 and 6 (falls of the Mazaruni River, British Guiana); EIGENMANN, 1915, fig. 13 on p. 270 only (dentition of one of the British Guiana specimens).

The front teeth of the outer row of the upper jaw of this species are well separated from one another (Eigenmann, 1915, fig. 13), as contrasted with *M. setiger.* In large specimens the anterior midventral scutes are buried in flesh. The front dorsal rays in the female are not much longer than the posterior rays, and the dorsal fin outline is rounded rather than falcate; the anterior dorsal rays of the adult male reported on by Eigenmann (1912) have short free filaments. Only very large specimens from British Guiana (those of Schomburgk and Eigenmann, 1912) are positively identifiable as this species.

The name *Myletes pacu* Schomburgk is not preoccupied by *Myletes paco* (sic) Humboldt. *Myletes divaricatus* is questionably identified as this species because the teeth of the outer row of the upper jaw are said to be "assez épaisses; le bord est triangulaire et pointu." In other characters *M. divaricatus* seems to be closer to *M. setiger;* however, it has a lower number of anal rays than either *M. pacu* or *M. setiger.* Another possibility is that *M. divaricatus* is the adult male of *M. rhomboidalis.*

6. **Myleus torquatus** (Kner)

Myletes torquatus KNER, 1859, p. 24, pl. 1, fig. 4 (Rio Branco, State of Amazonas, Brazil).

The most striking feature of this species as described by Kner is the black vertical band on the sides. However, I have here identified as this species one specimen 97 mm. long from the vicinity of Santarem, State of Pará, and ten specimens 94-104 mm. from Maués, on the southern channel from the Madeira into the Amazon, State of Amazonas, Brazil (M.C.Z. No. 19104); in the Santarem specimen the blotch on the side is completely lacking and in the Maués material it is faint. All agree with *M. torquatus* in having a black caudal margin, and in meristic characters (see table 2).

7. **Myleus ternetzi** (Norman)

Paramyloplus ternetzi NORMAN, 1929, p. 828, pl. 1 (Maparú Rapids, Approuague River, French Guiana).

This species is distinctive because of the large black blotch which extends from the anal forwards on to the body but does not reach the lateral line. Conical teeth in the lower jaw absent. About 10 gill rakers below.

This species is known only from a single specimen.

8. **Myleus schomburgkii** (Jardine)

Tetragonopterus schomburgkii Jardine, in Schomburgk, 1841, p. 243, pl. 22 (Rio Negro).

?*Myletes palometa* Valenciennes, in Cuvier and Valenciennes, 1849, p. 214 (Orinoco at the mouth of the Rio Jao).

Myletes divaricatus (*non* Valenciennes), Kner, 1859, p. 23 (Rio Branco).

Myletes schomburgkii, Steindachner, 1876, p. 86 (on Kner's specimen?).

Myloplus schomburgkii, Eigenmann, 1915, p. 271, pls. 56 and 57 (Manaos and Santarem on the Amazon); Norman, 1929, p. 824 (Rio Madeira).

9. **Myleus rhomboidalis** (Cuvier)

Myletes rhomboidalis Cuvier, 1818, p. 449, pl. 22, fig. 3 (Amazon); Cuvier and Valenciennes, 1849, p. 210 (Amazon).

Myletes discoideus Kner, 1859, p. 30 (Bananeira; Rio Branco; Mato Grosso).

Myletes parma Günther, 1864, p. 374 (Rio Capin, south of Belém, State of Pará, Brazil).

Myloplus rhomboidalis, Eigenmann, 1915, p. 271 (Manaos; Rio Madeira); Norman, 1929, p. 827 (Amazon).

This species and *M. latus* seem to make up a rather easily distinguishable species complex. A specimen of *M. rhomboidalis* 120 mm. long from the Santarem market has the dorsal, anal, and caudal with obscure dusky margins; there is a narrow naked area extending along the dorsal midline from the supraoccipital to the predorsal scute. The head is short and broad, and the eye large.

10. **Myleus latus** (Schomburgk)

Tetragonopterus latus Schomburgk, 1841, p. 241 (Guiana).

Myletes latus, Müller and Troschel, 1845, pp. 24 and 37 (Essequibo River, British Guiana).

Myloplus rhomboidalis (*non* Cuvier), Eigenmann, 1912, p. 392, pl. 58, figs. 1-4 (British Guiana).

Myloplus latus, Norman, 1929, p. 827 (Guiana).

This species is closely related to, if not identical with, *M. rhomboidalis*.

11. **Myleus rubripinnis** (Müller and Troschel)

Myletes rubripinnis Müller and Troschel, 1845, pp. 23 and 38, pl. 9, fig. 3 (Essequibo River, British Guiana).

Myloplus rubripinnis, Eigenmann, 1912, p. 391, pl. 57, fig. 2 (Crab Falls, Rockstone, Bartica, Malali, and Tumatumari, all in British Guiana).

The species complex including *M. asterias* and *M. rubripinnis* is extremely confusing. Two species of the group, those just named, occur in

British Guiana; at least two are in the Amazon; and one is in the Paraguay system. The species of any one area can apparently be distinguished, but the criteria so used break down when applied to other areas. The treatment and synonymies of the complex, particularly of the Amazonian forms, here presented are entirely provisional.

12. **Myleus asterias** (Müller and Troschel)

Myletes asterias Müller and Troschel, 1845, pp. 24 and 36, pl. 10, figs. 2 and 2a (Essequibo River, British Guiana); Günther, 1864, p. 373 (Essequibo River, British Guiana).

Myletes ellipticus Günther, 1864, p. 375 (Essequibo River, British Guiana).

Myloplus asterias, Eigenmann, 1912, p. 392, pl. 57, fig. 3 (Malali, British Guiana); Norman, 1929, p. 824 (British Guiana).

?Myloplus schulzei Ahl, 1938, p. 191 (South America).

This species is most readily recognized by the bright orange spots on the sides. Unfortunately, according to literature, these are not always present. The adult males of *M. asterias* seem never to develop filamentous dorsal rays.

13. **Myleus maculatus** (Amaral Campos)

?Myletes lobatus Valenciennes, in Cuvier and Valenciennes, 1849, p. 212 (Amazon).

Myleus pacu, Eigenmann (in part, *non* Schomburgk), 1915, p. 269, fig. 12 (Manaos, State of Amazonas, Brazil).

Tomète maculatus Amaral Campos, 1944, p. 211, fig. (Rio Amazonas).

I have examined specimens of at least two forms of the *M. asterias-rubripinnis* group from the Amazon region. One is represented by six specimens, 174 to 208 mm., from Maués, on the southern connective between the Rio Madeira and the Amazon (M.C.Z. Nos. 19229 and 19310). These specimens differ from the Tocantins form of the complex considered below in having the dorsal rays of the adult males prolonged; the dorsal-adipose distance contained 2.2-4.5 times in the dorsal base; the depth of the caudal peduncle greater than its length to the end of the vertebral column; the dorsal origin nearer the tip of snout than the end of the vertebral column; the dorsal base shorter than the anal base; the middorsal line scaleless between supraoccipital and dorsal; the greatest width of opercle 2½-3 times in its greatest depth; the teeth broader.

The specimens described above also differ from the description of *Tomète maculatus* in a number of ways. The latter species seems to have a longer dorsal, a shorter dorsal-adipose interspace, and blotches on the sides. However, Eigenmann's specimens of "*M. pacu*" from Manaos are more or less intermediate between the Maués specimens and the description of

T. maculatus. The dorsal counts in the three Manaos specimens are 25, 27, 28; the dorsal-adipose distance 4.0, 4.0, 5.4; and one of the specimens is blotched, the others plain.

Consequently, the identification of the specimens from Maués with *M. maculatus* is chosen as a preferable alternative to the description of a dubious new species in an already confused group.

14. **Myleus gurupyensis** Steindachner

Myleus gurupyensis STEINDACHNER, 1911, p. 342 (Rio Gurupí near Chatão, between the States of Maranhão and Pará, Brazil).

Myloplus arnoldi AHL, 1936, p. 26 (Amazonas).

I provisionally identify as this species six specimens from the Rio Tocantins, 79-180 mm. The largest male is 124 mm. long and is perhaps not big enough to develop dorsal filaments. Other characters in which these specimens differ from the Maués form, identified above as *M. maculatus,* are dorsal-adipose interspace contained 4.3-5.7 in dorsal base; depth of caudal peduncle less than its length to end of vertebral column; dorsal origin about equidistant from end of vertebral column and posterior nostril; dorsal base slightly longer than anal base; much of the middorsal line scaled between the supraoccipital and the predorsal scute; greatest width of opercle $3\frac{1}{2}$ in its greatest depth; teeth narrow and thicker.

The Rio Tocantins specimens do not disagree greatly with Steindachner's description of *M. gurupyensis,* but the Amazon forms of this species complex are so confusing that any identification at all is rather tenuous. The relationship between this species and *M. asterias* seems to be rather close.

Myloplus arnoldi Ahl was described from a juvenile specimen 58 mm. in total length.

15. **Myleus tieté** (Eigenmann and Norris)

Myletes tieté EIGENMANN AND NORRIS, 1900, p. 359 (Rio Piracicaba, tributary to Rio Paraná, Brazil).

Myleus tiete, EIGENMANN AND KENNEDY, 1903, p. 529 (Rio Piracicaba).

Myleus levis, EIGENMANN AND MCATEE, in Eigenmann, McAtee, and Ward, 1907, p. 142, pl. 42, fig. 2 (Bahia Negra on the Río Paraguay, Paraguay).

Myloplus levis, EIGENMANN, 1915, p. 271 (Río Paraguay basin); NORMAN, 1929, p. 825 (Río Paraguay).

This form seems to be the Paraguay basin representative of the *M. asterias-rubripinnis* complex. It appears to be separable from related forms chiefly on the basis of the broader interorbital. In Eigenmann and McAtee's original description of *M. levis* no comparison is given between that species and *M. tieté.* In fact, through an oversight of one sort or another, *M. tieté* is not included in Eigenmann, McAtee, and Ward's list of fishes from the Paraguay basin (1907, p. 154).

VI. **Acnodon** Eigenmann

The generic name *Acnodon* is based on the misimpression that the type species, *A. oligacanthus,* from Guiana, had no predorsal spine. The best description and figure of the genus and hitherto single known species are to be found in Steindachner (1917, p. 54, pl. 6, fig. 4). A second species of *Acnodon* is described below.

Teeth 5+2/5+1; no teeth on maxillary. Branchiostegal rays 4-4; gill rakers few, 9-11/6-10; first exposed suborbital deeper than the others. Abdominal scutation absent before ventrals; 6-8 scutes between ventral origins and anal; scales small. Predorsal spine present; rayed dorsal with 15-19 rays; adipose of moderate size, not rayed; anal count 33-36. (Diagnosis based primarily on *Acnodon normani,* described below.)

Acnodon normani Gosline, new species

Table 3; plate 3; figure 5b

Holotype: C.A.S. 20223, 127 mm. in standard length, collected by Dr. Carl Ternetz, January 25, 1924, in Rio Santa Teresa, a western tributary of the upper Rio Tocantins, State of Goiaz, Brazil.

Paratypes: C.A.S. 20224 and U.M.M.Z. 144344, 17 specimens, 68-115 mm. in standard length, with the same collection data as the holotype.

Also examined: C.U. No. 3272, collected by C. F. Hartt (no locality or collection date recorded).

Five teeth on each side in the outer row above, the first three conical, somewhat hooked, the lateral two more or less molariform. Second row in the upper jaw widely separated from the front row, consisting of two more or less triangular molars on each side, each tooth with one apex of the triangle pointing posteriorly, the other two laterally; crowns with the anterior rim low, the postero-lateral rims somewhat raised. No teeth on maxillary. Lower jaw with 5 teeth on each side in the outer row, the front two forming a fairly straight line across the front of the jaw, the individual teeth fitting in between the molars of the upper jaw when the mouth is shut. A fleshy tab behind the two central teeth of the lower jaw, but no conical teeth.

Lower jaw very short, undershot, resembling the jaw of *Creagrutus.* Maxillary freely movable, partly sliding under the suborbital bones, with a

TABLE 3

Counts and measurements of the holotype and eleven paratypes of *Acnodon normani*. All measurements, other than standard length, are given in thousandths of standard length.

	Holotype	Paratypes											Range	Average
Standard length (mm.)	127	115	108	105	100	85	80	78	74	74	70	68	68-127	90
Total number of gill rakers	22	18	20	20	18	19	18	17	15	18	22	19	15- 22	19
Total number of dorsal rays	18	17	17	19	15	18	18	18	18	18	19	17	15- 19	18
Total number of anal rays	35	35	33	35	36	33	35	36	35	35	35	35	33- 36	35
Number of pectoral rays	17	15	16	18	16	16	15	17	18	17	16	14	14- 18	16
Number of ventral rays	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Total number of mid-ventral scutes	6	7	7	8	8	7	7	8	6	6	7	7	6- 8	7
Depth	536	548	547	553	560	565	537	513	527	527	515	573	513-573	542
Head	294	287	293	287	293	296	296	296	308	296	289	300	287-308	294
Snout	99	102	103	101	104	105	102	101	110	111	101	101	99-111	103
Eye	87	92	92	93	94	96	101	101	107	104	108	104	87-108	98
Interorbital	89	90	84	88	90	89	89	89	91	90	86	87	84- 91	88
Length of maxillary	64	61	72	67	77	79	70	67	77	68	59	60	59- 79	68
Length of lower jaw	79	87	82	82	87	85	93	91	96	99	87	75	75- 99	87
Post-orbital part of head	120	114	121	116	109	125	121	120	120	112	119	115	109-125	118
Length of occipital process	98	102	100	108	106	107	104	105	93	99	99	100	93-108	102
Distance from base of occipital process to origin of rayed dorsal	324	329	318	336	325	345	320	322	312	306	291	307	291-345	320
Distance from tip of snout to origin of rayed dorsal	557	558	562	570	568	575	562	559	568	556	543	547	543-575	560
Distance from origin of rayed dorsal to end of vertebral column	590	576	572	612	592	588	620	606	586	579	601	554	554-620	590
Length of longest dorsal ray	385	392	368	392	....	598	611	....	487	....	417	....	368-611*	456*
Length of last dorsal ray	95	98	91	94	109	99	101	101	108	99	100	106	91-109	100
Length of dorsal base	212	228	232	244	203	229	229	227	228	228	214	216	203-244	224
Distance from base of last dorsal ray to origin of adipose	160	176	177	174	176	177	180	181	180	169	170	160	160-181	173
Length of adipose base	80	69	78	78	92	74	77	91	69	78	87	74	69- 92	77
Depth of caudal peduncle	87	90	96	84	89	93	101	82	91	90	86	84	82-101	89
Length of caudal peduncle	109	109	114	99	103	104	101	102	105	99	96	112	96-114	104
Length of anal base	277	273	286	282	274	273	270	258	257	275	261	259	257-286	270
Length of longest anal ray	261	236	286	270	301	292	270	272	....	285	281	259	236-301*	274*

* Based on fewer than twelve specimens; see individual figures.

fleshy flap on its lower tip. A fringed membrane between the maxillary and the lower jaw. Lower lip thick, its upper surface, against which the outer teeth of the upper jaw bite, furry.

First exposed suborbital the largest of the series.

Gill rakers short and simple, those of the upper arch thin and not widely spaced; posterior 4 or 5 rakers of the lower arch relatively gross and widely spaced; anterior rakers of the lower arch more or less rudimentary, easily missed in counting.

Scales small; about 135 transverse rows above the lateral line in the holotype, 115-125 in four paratypes; 46 between dorsal origin and lateral line, 44-52 in four paratypes; 30 between lateral line and ventral insertion, 29-31 in four paratypes.

Supraoccipital process short. Predorsal spine strong. Outline of dorsal fin falcate; 3rd and 4th rays prolonged, in one specimen over half the standard length of the fish. Adipose fin fairly large, characteristically shaped (see plate), arising from a middorsal keel of flesh. Pectorals and ventrals long for the subfamily, the latter with basal scales which are about one-fourth the length of the fins. Ventral surface before pelvic fins somewhat flattened, covered with ordinary body scales. Midventral scutes behind ventral insertion strong, 5 to 7 simple plus 1 pair at front of anus; no scutes between anus and anal. Anal falcate anteriorly, no second lobe developed in specimens at hand, with a narrow basal sheath of scales.

Sides silvery, with vertical bluish stripes extending downward from the back nearly to lateral line (not shown in plate). Dorsal interradial membranes dusky. Caudal with a dusky border.

Acnodon normani differs at once from *A. oligacanthus* in the sharper snout and the more undershot jaw. In *A. oligacanthus* the molariform teeth of the inner row of the upper jaw are said to be just behind the teeth of the outer row; in *A. normani* the two rows of premaxillary teeth are the most widely separated of any serrasalmine known.

Named for the late John Roxbrough Norman, as partial recognition of his excellent work on the Serrasalminae as well as in other groups.

VII. **Metynnis** Cope

The generic synonymy of this genus is that given by Norman (1929, p. 815).

Metynnis may be at once distinguished from other genera of Serrasalminae by the long, low adipose fin. In this character the genus seems to represent a specialized offshoot of the serrasalmine stock, and is without close relatives.

The species of *Metynnis* are not readily separable from one another on the basis of superficial characters, at least in museum specimens. All have much the same form, counts, and markings. Like other serrasalmines, most of the species seem to have spotting in the juveniles, which is lost in the adults. On the other hand, in some of the largest specimens of *M. maculatus* the dorsal interradial membranes are spotted, while in smaller specimens the dorsal is plain. Though the spotting of the sides and of the dorsal is correlated in part with growth, considerable individual variation is also shown.

The half grown, as indicated by some specimens at least, have the anterior rays of the dorsal more elongate and the depth somewhat greater than in either the young or the adults.

Sexual differentiation appears to be slight, though the males do have the anal outline slightly lobate in front. Sexually mature adults of *M. maculatus* were not found which were less than about 120 mm. in length. The largest specimen of this genus I have seen is 145 mm. in standard length.

There is one previous revision of *Metynnis* (Ahl, 1924, pp. 15-31). In this work Ahl recorded 18 species of which 9 were described as new. There are certain *a priori* grounds for suspicion concerning the value of Ahl's revision. In the first place Ahl seems to have examined only 36 specimens. Second, though he described nine new species, he identified material with only three of the nine previously known species, and one of these three is a form he himself had described earlier in an aquarium journal. Three of Ahl's new species were based on aquarium specimens without definite original locality, and one of these, *M. seitzi,* was based on a single fish which is ''sehr beschädigt'' and has the eye and the adipose fin ''abgefressen.'' Finally it appears that the only characters which Ahl gave to differentiate his new species, those cited in his key, are based on trivialities or abnormalities. Nevertheless, to check this last point, specimens of *Metynnis* in the Museum of Comparative Zoology and in the Carnegie Museum, as well as those borrowed from the California Academy of Sciences and those in the University of Michigan Museum of Zoology, were examined. On the basis of the 100 or so specimens available I have been able to recognize the six species dealt with below; of these six, four are so closely related as to make specific differentiation somewhat doubtful.

The species are not illustrated because they look too much alike to make figures of each worth while. Furthermore, all the species here recognized have been adequately figured before.

Teeth 5+2/4+1; no teeth on maxillary. Gill rakers 7-29/12-31; branchiostegals 4-4; first exposed suborbital somewhat deeper than the others. Abdominal scutes 27-41; scales small. Predorsal spine present, often dentate on its upper surface; dorsal rays 15-20; adipose long and low; anal 36-46.

The range of *Metynnis* is from the Orinoco to La Plata. The genus is apparently absent in the Magdalena drainage and in Eastern Brazil from the São Francisco southwards.

KEY TO THE SPECIES OF METYNNIS

1. Total number of gill rakers about 60, the longest nearly equal to the diameter of the eye .... 1. *M. luna*

— Total number of gill rakers fewer than 40, the longest less than one-half the diameter of the eye 2

2.(1) Occipital process long, contained 2.4 or fewer times in the distance from its base to the origin of the dorsal; adipose fin particularly long and low, its distance from the base of the last dorsal ray contained 1.5 or more times in adipose base .... 2. *M. hypsauchen*

— Occipital process short, contained 2.6 or more times in the distance from its base to the origin of the dorsal; adipose fin relatively short and high, its distance from the base of the last dorsal ray usually contained about 1.2 times in adipose base, though as much as 1.6 in some individuals 3

3.(2) Ventral scutes greatly developed, the distance between the bottom of the ventral base and the tip of the scute below equal to more than one-half an eye diameter .... 3. *M. mola*

— Ventral scutes comparatively little developed, the distance from the bottom of the ventral base to the tip of the scute below it less than one-half an eye diameter 4

4.(3) Ventral scutes 29 to 37 5

— Ventral scutes 38 to 41 .... 6. *M. maculatus*

5.(4) Total number of gill rakers 21 to 30; scales bordering the naked middorsal line between the base of the occipital process and the dorsal origin about 45 to 50; lowest point in the ventral outline usually under or before the ventral origin .... 4. *M. lippincottianus*

— Total number of gill rakers 17 to 23; scales bordering the midline between the base of the occipital process and the dorsal origin about 55 to 65; lowest point in the ventral outline usually between ventral origin and anal .... 5. *M. argenteus*

1. **Metynnis luna** Cope

Metynnis luna COPE, 1878, p. 692 (Peruvian Amazon); FOWLER, 1907, p. 479, fig. 58 (on the type).

Metynnis guaporensis EIGENMANN, 1915, p. 267, pl. 54 (Macièl, Rio Guaporé; and San Joaquin, Bolivia).

Specimens examined: M.C.Z. 19140 in part, one, 114 mm., Silva, Lake Saraca, 1866, S. V. R. Thayer; M.C.Z. 19136 in part, one, 93 mm., Lake Hyanuary, 1866, L. Agassiz.

The general appearance of this fish is well shown in Eigenmann's (1915) plate. Museum specimens of this species resemble the others of the genus superficially, except that the operculum is somewhat more extended posteriorly. The gill rakers are far longer and more numerous than in other forms of *Metynnis,* and the difference is easily seen by casual inspection of the gill arch.

The type of this species, like other specimens described by Cope from the same collections (for example *Myletes herniarius),* seems to have been abnormally deep. This may be a peculiarity of preservation, since the fishes from the Amazon which were reported on by Cope were in notoriously poor state when received.

Counts and measurements for the specimens examined are given in table 4.

2. **Metynnis hypsauchen** (Müller and Troschel)

Myletes hypsauchen MÜLLER AND TROSCHEL, 1845, pp. 23 and 38, pl. 10, fig. 1 (Essequibo River, British Guiana); MÜLLER AND TROSCHEL, in Schomburgk, 1848, p. 637 (Tapacuma Lake, Guiana); CUVIER AND VALENCIENNES, 1849, p. 219 (Amazon and Guiana); KNER, 1859, p. 26 (Caiçara, Marabitanos); GÜNTHER, 1864, p. 376 (Essequibo River); STEINDACHNER, 1881, p. 28 (Amazon near Santarem and Tefé; Rio Trompetas and Rio Guaporé).

?Myletes (Myleus) orinocensis STEINDACHNER, 1908, p. 365 (Orinoco near Ciudad Bolivar).

Metynnis hypsauchen, EIGENMANN, 1912, p. 389 (British Guiana); AHL, 1924, p. 21 (Guiana, Bolivia, and Rio Jamundá near Faró); NORMAN, 1929, p. 819 (Guiana, Amazon).

Metynnis calichromus AHL, 1924, p. 18, fig. 1 (Lago de Faró, Jamundá).

Metynnis calichromus schreitmülleri AHL, 1922, (not seen).

Metynnis schreitmülleri AHL, 1924, p. 19 (Amazon).

Metynnis ehrhardti AHL, 1926, p. 273 (Mundurucú, on Rio Manacapuru, Solimoes, State of Amazonas).

Metynnis fasciatus AHL, 1931, p. 407, fig. p. 409 (Rio Capiuru).

Material examined: M.C.Z. 19140 in part, seventeen, 87-123 mm., Silva, Lake Saraca, 1866, S. V. R. Thayer; M.C.Z. 30126, one, 76 mm., Rockstone, Essequibo River, British Guiana, 1908, C. H. Eigenmann; C.M. 5732 a-d, four, 108-130 mm., Santarem, Dec. 15, 1909, J. D. Haseman; C.M. 5733 a-b, two, 53 and 73 mm., Manaos, Nov. 29, 1909, J. D. Haseman; C.A.S. 20226, 106 mm. and U.M.M.Z. 144340, 106 mm., two, Santarem River, Aug., 1924, C. Ternetz; C.A.S. 20225, one, 58 mm., Fazenda Sta. Cruz, Lagoa Grande into Amazon, Hyanuary, July 15, 1924, C. Ternetz.

This is the species of *Metynnis* most commonly met with in collections. It seems also to have the widest distribution in the genus with the possible

TABLE 4

Ranges and averages of counts and measurements for two species of *Metynnis*. All measurements, other than standard length, are given in thousandths of standard length.

Species	*M. luna*		*M. hypsauchen*	
Catalogue numbers	M.C.Z. 19140 in part	M.C.Z. 19136 in part	M.C.Z. 19140 in part	C.A.S. 20226 U.M.M.Z. 144340
Locality	Lake Saraca	Lake Hyanuary	Lake Saraca	Santarem River
Number of specimens	1	1	17*	2
Standard length (mm.)	114	93	87-123 (104)	106
Total number of gill rakers	60	53	26- 36 (32) [16]	31- 33
Total number of dorsal rays	19	17	18- 22 (19)	17- 18
Total number of anal rays	43	41	38- 46 (41)	39- 40
Number of pectoral rays	16	14	14- 17 (15) [8]	14
Number of ventral rays	6	5	6- 7 (6.9) [8]	7
Total number of mid-ventral scutes	27	27	26- 31 (29)	28- 29
Number of scales along mid-dorsal line between base of occipital process and origin of rayed dorsal	......	......	......	47
Number of scales along adipose base	......	......	......	......
Depth	799	903	800-895 (834)	793-849
Head	341	347	298-329 (311)	277-304
Snout	76	78	67- 92 (82)	75- 77
Eye	82	90	89-106 (97)	87- 91
Interorbital	133	138	129-146 (136)	123-131
Post-orbital part of head	183	193	144-163 (152)	140-150
Greatest width of operculum	89	100	60- 74 (68)	64- 65
Greatest depth of operculum	266	290	235-279 (253)	239-241
Length of occipital process	200	215	197-238 (220)	167-199
Distance from base of occipital process to origin of rayed dorsal	442	467	447-486 (463) [15]	470-481
Distance from tip of snout to origin of rayed dorsal	597	646	609-660 (635)	634-639
Distance from origin of rayed dorsal to end of vertebral column	626	651	607-656 (631)	616-655
Length of longest dorsal ray	......	......	254-309 (276) [14]	......
Length of dorsal base	247	245	228-261 (246)	239-246
Distance from base of last dorsal ray to origin of adipose	107	129	87-119 (103)	88-111
Length of adipose base	185	197	173-202 (191)	197-209
Depth of caudal peduncle	93	105	97-111 (104)	103-111
Length of anal base	431	493	423-478 (450)	409-419

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*If range and average are based on fewer specimens, the number of specimens used is indicated in brackets.

exception of *M. argenteus,* extending at least from Guiana, through the Amazons, into the Paraguay system.

Though *M. hypsauchen* superficially resembles the other species of the genus, it is at once distinguishable by its long, low adipose. The great length of the supraoccipital process will likewise distinguish *M. hypsauchen* from all but *M. luna.* In number of gill rakers the species falls between *M. luna* and the *M. maculatus* group, only slightly overlapping the range of the latter. In color *M. hypsauchen* is plain silvery, and some specimens at least have vertical bluish bars on the upper sides.

Counts and measurements for the Lake Saraca specimens are given in table 4.

3. **Metynnis mola** Eigenmann and Kennedy

Metynnis mola Eigenmann and Kennedy, 1903, p. 528 (Arroyo Trementina, Paraguay); Eigenmann, McAtee and Ward, 1907, p. 141, pl. 42, fig. 1 (Puerto Murtinho, Río Paraguay and Río Otuquis, a western tributary of the Río Paraguay).

Metynnis otuquensis Ahl, 1924, p. 26 (Bahia Negra, Río Otuquis).

Material examined: C.M. 10050, paratype, 64 mm., from Arroyo Trementina, tributary to Río Aquido Canigi, Río Paraguay drainage.

This species, as exemplified by the specimen examined, differs from the rest of the *M. maculatus* group chiefly in the far greater development of the ventral scutes. These somewhat resemble the ventral scutes of *Mylossoma* in their vertical elongation and in their considerable projection beyond the skin of the abdomen. Furthermore, the forked scutes which occur behind the ventral origin have the prongs of the fork extending more or less vertically and parallel to one another rather than, as in other species, flaring out into a more or less double ended anvil.

Counts and measurements for the specimen examined are given in table 5.

4. **Metynnis lippincottianus** (Cope)

Myletes lippincottianus Cope, 1871, pp. 561, 566, fig. (Pará).

?Myletes lippencottianus (sic), Ulrey, 1895, p. 299 (Brazil).

Sealeina lippincottianus, Fowler, 1907, p. 479, fig. 57 (Pará).

Metynnis (Myleus) orbicularis Steindachner, 1908, p. 364 (Rio Parnahyba near Victoria and Santa Filomena, and Santarem).

?Metynnis goeldii Eigenmann, 1910, p. 443 (based on *Myletes lippencottianus,* Ulrey, 1895).

Metynnis roosevelti Eigenmann, 1915, in part, p. 268, pl. 55 (Manaos and Santarem).

Metynnis seitzi Ahl, 1924, p. 28 (aquarium specimen, probably from the Amazon).

Material examined: C.A.S. 20227, one, 76 mm., Fazenda Sta. Cruz, Lago Grande into Amazon, Hyanuary, July 15, 1924, C. Ternetz; C.A.S. 20228, 123 mm. and U.M.M.Z. 144345, 90 mm., two, Santarem market, Sept., 1924, C. Ternetz; C.A.S. 20229, one, 117 mm., Santarem market, Oct., 1924, C. Ternetz.

Of the species listed in the synonymy, the only description of *M. goeldii* runs as follows (Ulrey, 1895, p. 300): "Two specimens from Brazil. The dorsal has a conspicuous black blotch on the upper part of the first rays and the ventrals are dark colored." Dr. Raney has been good enough to look for, but could not find, Ulrey's specimens, which are presumably at Cornell with the rest of the material reported on by Ulrey.

Metynnis lippincottianus, well illustrated by Eigenmann (1915, pl. 55) under the name *M. roosevelti,* differs from *M. maculatus* in the fewer ventral scutes, and from *M. mola* in the lesser prominence of these scutes. From *M. argenteus,* to which it is very closely related, it may be distinguished by the ensemble of characters stated in the key; of these, perhaps the best single character is the greater number of gill rakers in *M. lippincottianus.* The scales, though definitely larger than in *M. argenteus,* are very difficult to quantify. In many museum specimens they are missing altogether, at least from the midsides. In those specimens which have the scales present, they do not seem to be laid down in regular rows, and only a very rough approximation is possible. Such an approximation in a specimen 117 mm. from Santarem is 80 transverse rows, with 33 scales between the lateral line and the dorsal and 35 between the lateral line and the ventral bases. Another count on the same fish would probably vary by 5 scales from the above, while the scale number on different specimens seems to show much wider variation.

Besides the characters given in the key, *M. lippincottianus* seems to be less deep-bodied than *M. argenteus.* The snout is usually shorter, the interorbital narrower, and the dorsal profile above the eyes is more evenly convex, i. e., less indented. The dorsal rays in the specimens at hand are usually more numerous, and the spotting of the sides generally is far more prominent than in *M. argenteus.*

Counts and measurements for this species are given in table 5.

5. **Metynnis argenteus** Ahl

Metynnis maculatus EIGENMANN *(non* Kner), 1912, p. 390, pl. 57, fig. 1 (Lama Stop-Off, Rockstone, and Twoca Pan, British Guiana).

Metynnis argenteus AHL, 1924, p. 24 (Rio Tapajos, near Borin).

Metynnis eigenmanni AHL, 1924, p. 25 (Rio Tapajos, near Borin); Norman, 1929, p. 819 (Amazon).

Metynnis anisurus AHL, 1924, p. 27 (Rio Tapajos, near Borin).

Metynnis altidorsalis AHL, 1924, p. 22 (Paramaribo, Surinam).

Metynnis heinrothi AHL, 1924, p. 29 (aquarium specimen, probably from the Amazon).

Metynnis snethlageae AHL, 1924, p. 30 (Amazon).

Material examined: M.C.Z. 19136 in part, twenty-seven, 65-145 mm., Lake Hyanuary, 1866, L. Agassiz; M.C.Z. 19140 in part, three, 110-138 mm., Silva, Lake Saraca, 1866, S. V. R. Thayer; C.A.S. 20228, 125 mm. and U.M.M.Z. 144346, 106 mm., two, Santarem market, July, 1924, C. Ternetz; C.A.S. 20231, one, 94 mm., Santarem River, Aug., 1924, C. Ternetz.

This species seems to have been described several times by Ahl, though so far as I can determine it had not been named previous to his revision. The difficulty of distinguishing this form from *M. lippincottianus* makes the synonymies of both of them somewhat tenuous, as is in fact the specific distinction between the two. *Metynnis argenteus* often appears to be unspotted throughout life. On the other hand, traces of spots on the sides seem to be identifiable on some of the Hyanuary material which I have determined as this form. An approximation of the scale counts in a Santarem specimen 125 mm. in standard length is 95 transverse rows, with 50 scales between lateral line and dorsal origin, and 61 between lateral line and ventral origin.

Both males and females are represented among the larger specimens, at least, of the Hyanuary material of this species.

For a comparison of *M. argenteus* and *M. lippincottianus* see the latter species and table 5.

6. **Metynnis maculatus** (Kner)

Myletes maculatus KNER, 1859, p. 26 (Rio Guaporé); STEINDACHNER, 1881, in part, p. 128 (on the type).

Metynnis roosevelti EIGENMANN, 1915, in part, p. 268 (Bastos, on the Rio Alegre, a tributary to the Rio Guaporé); PEARSON, 1924, p. 48 (Lagoon near Reyes).

Material examined: U.M.M.Z. 66457-66460, four, 88-117 mm., Lagoon near Reyes, Bolivia, Oct., 1921, N. E. Pearson. This is part of the material reported on by Pearson in 1924.

Four closely related species seem to be represented in the *Metynnis maculatus* complex. Of these *M. maculatus* occurs in the Rio Madeira system, *M. mola* in the Paraguay, *M. lippincottianus* in the Amazon, and *M. argenteus* in Guiana, the Amazon, and probably in the Paraguay. It is possible that some of these forms will eventually prove to be geographical subspecies of one another, but too little is known about them to more than suggest such a hypothesis at the present time.

TABLE 5. Ranges and averages of counts and measurements for four species of *Metynnis*. All measurements, other than standard length, are given in thousandths of standard length.

Species	*M. mola*	*M. lippincottianus*	*M. argenteus*			*M. maculatus*
Cat. nos.	(paratype) C.M. 10050	C.A.S. 20227, 20228, 20229 U.M.M.Z. 144345	M.C.Z. 19136 in part	M.C.Z. 19140 in part	C.A.S. 20230, 20231 U.M.M.Z. 144346	U.M.M.Z. 66457-66460
Locality	Arroyo Trementina, Paraguay	Hyanuary (1) Santarem market (3)	Hyanuary	Lake Saraca	Vicinity of Santarem	Reyes, Bolivia
No. of specimens	1	4	27†	3	3	4†
S.L. (mm.)	64	*76**-123 (102)	65-145 (110)	110-138 (122)	94-125 (108)	88-117 (96)
Tot. no. of gill rakers	23	21- 25 (24)	17- 23 (20)	19- 22 (21)	19- 22 (20)	21- 25 (22)
Tot. no. of dor. rays	15	14- 16 (15)	16- 20 (18)	18- 19 (18)	15- 19 (17)	16- 18 (17)
Tot. no. of anal rays	40	39- *41* (40)	35- 43 (40)	37- 38 (38)	36- 39 (37)	39- 42 (40)
No. of pect. rays	14	14- 16 (15)	15[3]	14- 15 (14)	12- 15 (14)	15- 16 (15)
No. of vent. rays	5	5- 6 (5.8)	5- 7 (6.1)	7 (7)	6 (6)	6 (6)
Tot. no. mid-vent. scutes	36	*31*- 37 (34)	29- 36 (33)	32- 33 (33)	30- 33 (32)	38- 41 (40)
No. scales bet. base occ. process & or. rayed dor.	......	37- 52 (45)	57- 61[3]	......	59- 65 (61)	47- 56 (52)
No. scales along ad. base	......	16- 20 (18)	20- 25[3]	......	30- 33 (32)	16- 22 (20)
D.	858	667-822 (758)	762-884 (801)	783-832 (802)	807-867 (842)	712-738 (723)
H.	297	262-289 (276)	272-312 (288)	280-297 (289)	284-294 (288)	273-285 (280)
Sn.	78	56- 78 (67)	66- 87 (76)	67- 83 (76)	72- 76 (74)	69- 77 (74)
Eye	111	76- *93* (84)	76-103 (86)	86- 96 (91)	88- 96 (91)	76- 92 (86)
Interorb.	127	121-141 (129)	122-149 (132)	136-142 (139)	137-141 (139)	121-126 (123)
Post-orb. part of H.	133	138-144 (140)	117-156 (143)	122-142 (135)	140-149 (144)	134-146 (142)
Greatest width of oper.	70	*63*- 88 (73)	59- 98 (80)	63- 67 (65)	65- 73 (66)	65- 69 (67)
Greatest depth of oper.	229	212-234 (223)	218-251 (230)	216-231 (225)	219-233 (228)	219-235 (226)
L. of occ. process	173	119-152 (139)	130-183 (153)	158-163 (161)	157-167 (162)	144-150 (148)
Dist. from base of occ. process to or. rayed dor.	456	435-*476* (457)	425-501 (468)	419-449 (432)	424-473 (455)	422-447 (435)
Dist. from tip of sn. to or. rayed dor.	638	596-*652* (626)	597-684 (645)	606-646 (625)	623-662 (649)	601-632 (614)
Dist. from or. rayed dor. to end of vert. column	654	587-621 (598)	582-687 (617)[25]	605-617 (610)	620-633 (629)	587-610 (600)
L. of longest dor. ray	....	242-368 (309)	266-392 (349)[10]	327-373 (343)	256-437 (337)	280-355 (318)[2]
L. of dor. base	214	208-243 (221)	205-245 (231)[24]	238-252 (247)	222-247 (238)	223-245 (230)
Dist. from base of last dor. ray to or. of ad.	141	*107*-139 (120)	106-161 (132)	101-144 (117)	125-133 (129)	110-127 (116)
L. of ad. base	145	*133*-162 (150)	138-174 (155)	149-159 (153)	144-175 (158)	131-156 (146)
D. of caud. ped.	109	113-130 (119)	98-161 (114)	108-115 (112)	113-117 (114)	101-109 (105)
L. of anal base	502	392-*480* (431)	398-447 (420)	396-427 (410)	401-471 (444)	382-421 (398)

* Extreme of range in italics when it is the measurement of the Hyanuary specimen.

† If range and average are based on fewer specimens, the number of specimens used is indicated in brackets.

Metynnis maculatus differs at once from the other three in the greater number of ventral scutes. In other respects it is more or less intermediate between *M. lippincottianus* and *M. argenteus*. The absence of further differentiating characters might suggest that the scute number is an individual variation rather than a specific character. However, the high scute count found in the Reyes material is also recorded for Eigenmann's (1915) specimens from Bastos on the Rio Alegre, a tributary of the Rio Guaporé; for three specimens from the latter locality scute counts of 38, 38, and 42 are given. The counts given by Kner in his original description of the species are 33-35 simple plus 2-4 paired scutes. By contrast the abdominal serrae in 45 specimens of the other three related species examined range between 29 and 37.

This species, so far as known, is limited to the Madeira drainage.

Counts and measurements for specimens examined are given in table 5.

VIII. **Catoprion** Müller and Troschel

Teeth 5/6, tuberculate, widely spaced in a single very irregular row both above and below; no teeth on maxillary. Gill rakers 8/12, spiny; branchiostegals 4-4; first two exposed suborbitals much deeper than the others (fig. 5c). Abdominal scutes about 32; scales small. Predorsal spine well developed; dorsal rays about 17, the first few elongate; adipose rather long; anal about 37.

One species, *C. mento*, from the Amazon and Guiana.

Of the stomachs of four specimens examined, two were full of fish scales and two were empty except for a few fish scales; a small amount of unidentifiable debris was also found.

The general appearance of this peculiar fish is well shown in Eigenmann's plate (1912, pl. 56, fig. 3). The teeth are accurately illustrated by Müller and Troschel (1845, pl. 2, fig. 5).

IX. **Pygopristis** Müller and Troschel

The diagnosis of this genus is the same as that for *Serrasalmus*. The species of *Serrasalmus* grade imperceptibly into *Pygopristis*, and the distinction between the two, based on the number of tooth lobes, seems of doubtfully generic rank.

One species, *P. denticulatus*, from Guiana and the Amazon, is attributed to the genus by Norman (1929).

X. **Serrasalmus** Lacépède

Teeth 6/7, shearing; no teeth on maxillary. Gill rakers rudimentary; branchiostegals 4-4; 3 exposed suborbitals (fig. 5d). Abdominal scutes

22-37; scales small. Predorsal spine present; dorsal rays 14-20; adipose small, rayed in adults of *S. piraya;* anal 29-37. (Most of these counts are from Norman.)

Sixteen species recognized in Norman's (1929) revision.

To the described species dealt with by Norman, add *Serrasalmus boekeri* AHL, 1931, p. 406, fig. p. 408 (locality not stated, probably lower Amazon).

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Plate 1. *Mylesinus schomburgkii*, C. A. S. 20221, 205 mm., from the Upper Tocantins basin.

Plate 2. *Utiaritichthys sennae-bragai*, C. A. S. 20222, 168 mm., from the Lower Rio Tocantins.

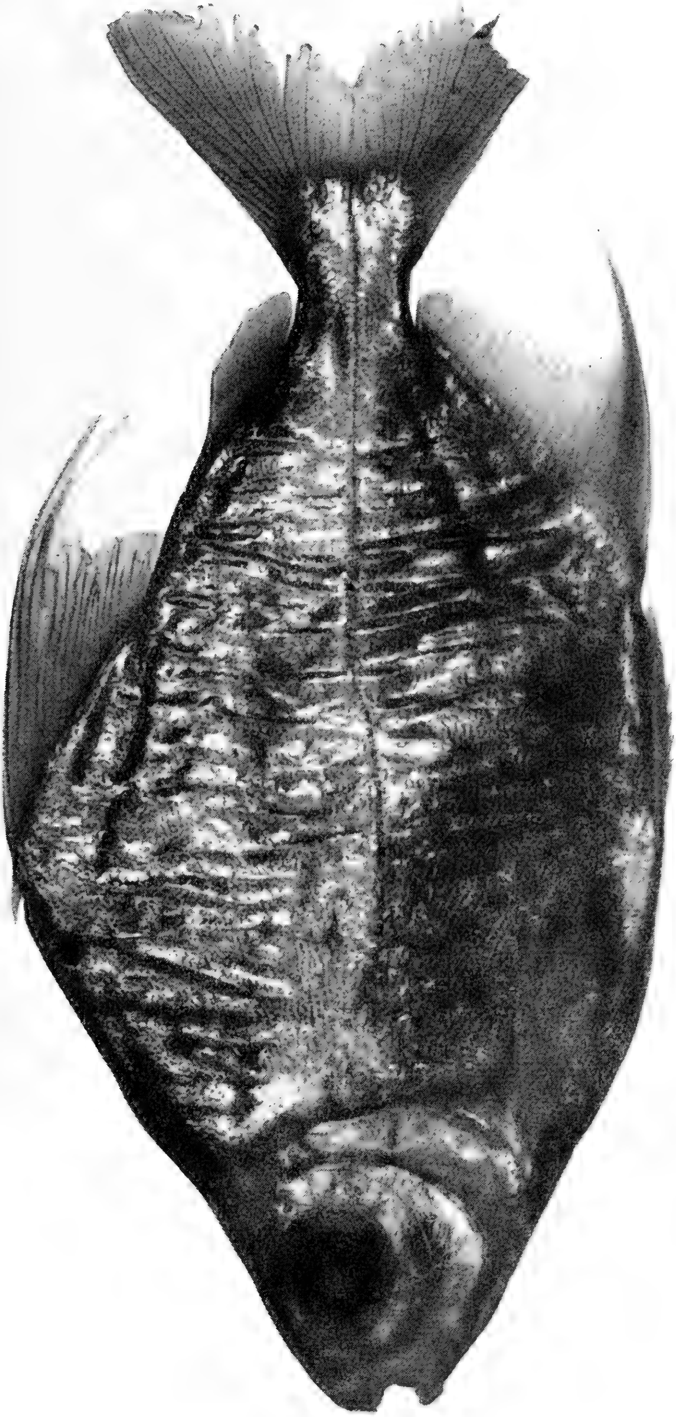

Plate 3. *Acnodon normani*, holotype, C. A. S. 20223, 127 mm., from the Upper Tocantins basin.

PROCEEDINGS

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THE TRICHOPTERA OF LOWER CALIFORNIA

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Considering the complete lack of organized information on the caddisflies of Lower California, the collections reported here are especially noteworthy. They are important also in view of the equally great void in our knowledge regarding the Trichoptera in western Mexico.

This report is based primarily on the 1938 collection of Dr. and Mrs. A. E. Michelbacher and Dr. E. S. Ross, and the 1941 collection of Dr. Ross and Dr. G. E. Bohart. For completeness, I have included five other species collected by Dr. H. J. Rayner.

Faunal Relationships

In this report, fourteen species of Trichoptera are recorded from the Peninsula, and at least four others are represented in the collections but are identified only to genus. An analysis of the fourteen identified species brings out some interesting relationships with the fauna of other parts of the Southwest.

Four species, *Chimarra utahensis, Oecetis inconspicua, O. disjuncta,* and *Helicopsyche borealis,* are widespread throughout either most of North America or the western montane area.

Four species are known from widely separated localities in the Southwest, extending from Oklahoma or Texas to Lower California. This group includes *Chimarra angustipennis* and *C. elia,* and *Marilia flexuosa* and *M. nobsca.* These four species appear to be part of a distinctive southwestern fauna which extends through most of Mexico.

The third group comprises two species, *Hydropsyche philo* and *Cheumatopsyche mickeli,* previously known only from western California. These two species belong to a small faunal element which seems to be restricted to the coastal mountains south of San Francisco. The Lower California peninsula is simply an extension of this general uplift. In view of this it is not surprising to find the same species at both ends of the chain.

Four of the species are known to date only from Lower California: *Rhyacophila rayneri, Chimarra laguna, Notiomyia sagittosa,* and *Lepidostoma rhino.* Each of the last three species is related to members of the southwestern fauna, whereas the first shows a relationship only with more northern Rocky Mountain and West Coast species. So little intensive collecting has been done through the southwestern United States and western Mexico that we have an extremely imperfect knowledge of the fauna of this entire area. It is therefore premature to suggest that any of these four species are relicts confined now to Lower California, rather it is to be expected that they will prove to belong to either the more widely distributed southwestern fauna, or to the more restricted coastal fauna.

It would be interesting if future collecting should show that some of these species, or others yet undiscovered, are actual relict species confined to this area. It is hoped that further investigation of this general region continues, in order to test some of these possibilities.

FAMILY **RHYACOPHILIDAE**

To date only the genus *Rhyacophila* has been reported from Lower California, although the southwestern genera *Atopsyche* and *Protoptila* probably occur there also.

Rhyacophila rayneri Ross, new species

In many respects this species appears most closely related to *R. iranda* Ross but differs from it and its relatives in the elongate, tongue-like projection of the ninth tergite and other characteristics of the genitalia.

Male. Length from front of head to tip of folded wings, 12 mm. Color dark brown, appendages and venter lighter, wings a rich brown on which is superimposed an indefinite irrorate pattern of paler markings. General structure typical for genus. Genitalia as in figure 1. Ninth segment narrow, the dorsum produced into a long narrow strap with which the tenth tergite articulates. Tenth tergite also long and narrow, the mesal processes narrow and upturned, resting against the end of the dorsal process; the lateral plates do not seem to be sclerotized. Clasper with basal segment only slightly longer than deep, rhomboidal; apical segment moderately long with a large rounded heel and a projecting rounded toe, both bearing a patch of dark spicules. In addition to the basal cylindrical sheath, the aedeagus, figure 1B, consists of only a pair of sinuate, sclerotized, lateral arms and a central structure; this structure is apparently compound, consisting of a ventral part, bulbous at base, and a dorsal part which extends basad to the base of the lateral arms; from lateral view, this mesal structure looks something like an open mouth with the ventral part projecting upward and the dorsal part projecting slightly downward.

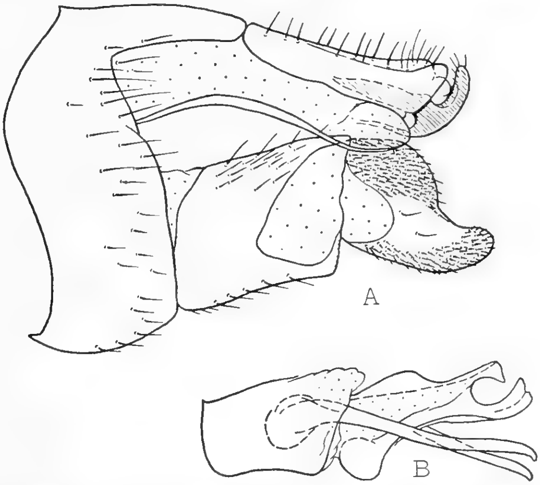

Fig. 1. *Rhyacophila rayneri*, new species; A, male genitalia, lateral aspect; *B*, aedeagus, lateral aspect.

Holotype, male. **Valadares, Lower California, Mexico, Rio Santo Domingo,** about 1,000 feet elevation, May 24, 1937, H. J. Rayner. In the collection of the Illinois Natural History Survey.

Family **PHILOPOTAMIDAE**

Chimarra utahensis Ross

Chimarrha utahensis Ross, 1938, Ill. Nat. Hist. Surv. Bull., 21:134. Knowlton and Harmston, 1938, Ent. News, 49:285.

Chimarrha idahoensis Ling, 1938[1], Pan-Pacific Ent., 14:64.

Chimarrha utahensis Ross, 1944, Ill. Nat. Hist. Surv. Bull., 23:292.

Type locality: Gandy, Utah.

Recorded distribution: Gandy, Utah; Lewiston, Ida.[1]

New records: LOWER CALIFORNIA—Rio Santo Domingo, Rancho San Antonio, 1,000 feet elev., May 24, 1937, H. J. Rayner, 2♂♂. CALIFORNIA—Santa Barbara, Feb., 1876, 1♂. SOUTH DAKOTA—Cascade Springs, July 30, 1935, H. C. Severin, 1♂. UTAH—Hurricane, April 25, 1941, Knowlton and Hardy, 1♂; Zion National Park, at Weeping Rocks, Sept. 2, 1943, G. F. Knowlton, 4♂♂. WYOMING—Nez Perce Cr., Yellowstone National Park, Aug. 1, 1940, T. H. Frison and T. H. Frison, Jr., 1♂.

This is the only member of the genus in North America which has a range scattered through the western montane region.

Chimarra angustipennis Banks

Chimarrha angustipennis BANKS, 1903, Proc. Ent. Soc. Wash., 5:242.
Chimarra angustipennis BANKS. Ross, 1944[1], Ill. Nat. Hist. Surv. Bull., 23:51.

Type locality: Hot Springs, Ark.

Recorded distribution: Arkansas and Oklahoma.[1]

New records: LOWER CALIFORNIA—Big Cyn, Sierra Laguna, Oct. 13, 1941, Ross and Bohart, 1♂. TEXAS—Austin, 2♂♂; west of Palo Pinto, June 12, 1943, in small stream, T. H. Frison, 1♂. MEXICO—Rancho La Golondrina, Rio Sabinas, Muzquiz Coahuila, June 24, 1938, Rollin H. Baker, 6♂♂, 3♀♀.

Chimarra elia Ross

Chimarra elia Ross, 1944, Ill. Nat. Hist. Surv. Bull., 23:269.

Type locality: Brackettville, Texas.

Recorded distribution: Brackettville, Texas.

New records: LOWER CALIFORNIA—Todos Santos, Nov. 10, 1941, Ross and Bohart, 25♂♂, 7♀♀. MEXICO, NUEVA LEON—Hacienda Vista Hermosa, Villa Santiago, elev. 1,500 feet, June 16, 1940, Hoogstraal and Knight, 3♂♂.

Chimarra laguna Ross, new species

This species belongs to the subgenus *Curgia* Walker and is a close relative of *C. betteni* Denning. From this species *C. laguna* differs in lacking paired projections near the dorsum of the eighth tergite, and in place of these having a single median projection. The tenth tergite and claspers also differ markedly in the two species.

Male. Length 9 mm. Color mostly black, the wings with patches of silvery hair as follows: a large one near base, two small ones near middle and a large one under the stigma and extending to M_{3+4}; legs beyond femora reddish brown. General structure typical for subgenus.

Genitalia as in figure 2. Eighth tergite, figure 2A, large, declivous posteriorly, and ending in a long sharp median spine; from beneath the base of this spine a partially sclerotized median ridge curves down to articulate with the top of the ninth tergite; the posterolateral corners of the eighth tergite are each produced into a large irregular flaplike projection bearing a cushion of long hair at its base and a row of stout macrochaetae along its posterior margin. Eighth sternite narrow and without ventral projections. Ninth segment, figure 2B, with dorsum produced into a narrow sinuate process articulating with eighth tergite, and with ventral

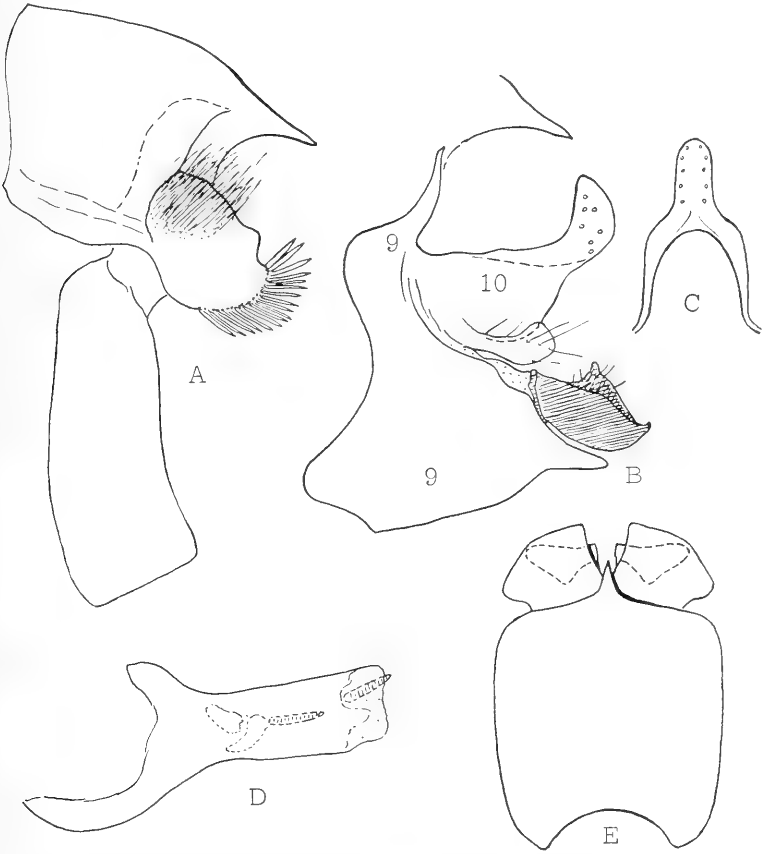

Fig. 2. *Chimarra laguna*, new species; *A*, eighth segment of male, lateral aspect; *B*, male genitalia, lateral aspect; *C*, tenth tergite, posterior aspect; *D*, aedeagus, lateral aspect; *E*, ninth sternite and claspers, ventral aspect.

portion large and bearing a posteromesal projection which lies beneath and between the bases of the claspers, figure 2E. Tenth tergite bulbous at base, upturned and forming a blunt, fleshy projection. Cercus short, curved, and enlarged at apex. Clasper short, somewhat rectangular from lateral view, heavily sclerotized. Aedeagus, figure 2D, with apex tubular and bearing two stout sclerotized internal rods.

Holotype, male. **Agua Caliente, Cape Region, Lower California, Mexico,** Oct. 18, 1941, Ross and Bohart. In the California Academy of Sciences.

Allotype, female. Las Animas, Sierra Laguna, Lower California, Mexico, Oct. 12, 1941, Ross and Bohart. Deposited with the holotype.

Paratypes. Same data as for holotype, 3♂♂. Same data as for allotype, 1♂. Two paratypes deposited with the holotype, two in the collection of the Illinois Natural History Survey.

Chimarra sp.

A few unassociated females, close to *C. angustipennis*, are left unidentified pending the collection of additional material from the following localities where the specimens were collected as indicated: Las Animas, Sierra Laguna, Nov. 12, 1941, Ross and Bohart, 3♀♀; Las Animas, Sierra Laguna, Nov. 16, 1941, Ross and Bohart, 1♀; and 5 miles south of Miraflores, July 10, 1938, Michelbacher and Ross, 1♀.

FAMILY **PSYCHOMYIIDAE**

Tinodes sp.

Only females were collected, and in this genus good distinguishing characters have not yet been found for this sex. The data for the three specimens taken are: 17 miles S. of Ensenada, June 14, 1938, Michelbacher and Ross, 2♀♀; and 2 miles S. W. Msn. San Vicente, Nov. 20, 1941, Ross and Bohart, 1♀.

FAMILY **HYDROPSYCHIDAE**

Smicridea sp.

A single female of this abundant southwestern genus is represented in the collection. This specimen was taken 17 miles S. Ensenada; June 14, 1938, Michelbacher and Ross.

Hydropsyche philo Ross

Hydropsyche philo Ross, 1941, Trans. Am. Ent. Soc., 67:90. Ross, 1944, Ill. Nat. Hist. Surv. Bull., 23:294.

Type locality: Monterey Co., Calif.

Recorded distribution: Monterey Co., Calif.

New records: LOWER CALIFORNIA—17 miles S. Ensenada, June 14, 1938, Michelbacher and Ross, 3♂♂, 4♀♀; 2 miles S. W. Mission San Vicente, Sept. 20, 1941, Ross and Bohart, 2♀♀. CALIFORNIA—Waddell Cr., Santa Cruz Co., Aug. 12, 1933, 2♀♀; Guatay, July 22, 1941, R. H. Beamer, 2♀♀, 8 miles E. of Santa Ana, May, 1944, J. E. Davis, 1♂.

Cheumatopsyche mickeli Denning

Cheumatopsyche mickeli DENNING, 1942, Can. Ent., 74:50. ROSS, 1944, Ill. Nat. Hist. Surv. Bull., 23:294.

Type locality: Morgan Hill, Santa Clara Co., Calif.

Recorded distribution: Morgan Hill, Santa Clara Co., Calif.

New records: LOWER CALIFORNIA—17 miles S. Ensenada, June 14, 1938, Michelbacher and Ross, 2♂♂. CALIFORNIA—Adobe Cr., Stanislaus Co., 12 miles W. of Patterson, May 23, 1948, Hugh B. Leech, 1 pupa; Marysville, July, 1947, C. O. Mohr, 1♂; Kern River powerhouse No. 3, Road's End, Sept. 25, 1940, Kaloostian and Simmons, ♂♂, ♀♀.

FAMILY **ODONTOCERIDAE**

Only the genus *Marilia* is represented in the Lower California collections.

Marilia flexuosa Ulmer

Marilia flexuosa ULMER, 1905, Naturhist. Hofmus. Wien. Ann., 20:70. BETTEN, 1934, N. Y. St. Mus. Bull., 292:242. ROSS, 1944, Ill. Nat. Hist. Surv. Bull., 23:300.

Anisocentropus fuscus BANKS, 1905[1], Trans. Am. Ent. Soc., 32:19.

Type locality: TEXAS. This species was originally described from 1♀ from Texas and 1♀ from Santa Catharina. I am hereby designating Texas as the restricted lectotype locality.

Recorded distribution: Texas, Brazil, and Arizona.[1]

New records: LOWER CALIFORNIA—Comondu, July 22, 1938, Michelbacher and Ross, 5♂♂, 1♀; 15 miles N. San Ignacio, Sept. 29, 1941, Ross and Bohart, 2♂♂, 1♀; 5 miles W. San Bartolo, July 13, 1938, Michelbacher and Ross, 1♂.

Marilia nobsca Milne

Marilia nobsca MILNE, Studies N. Am. Trich., 3:79. ROSS, 1944, Ill. Nat. Hist. Surv. Bull., 23:300.

Type locality: Fort Davis, Jeff Davis Co., Tex.

Recorded distribution: Type locality.

New records: Lower California—Comondu, July 22, 1938, Michelbacher and Ross, 1♂; 20 miles N. Comondu, July 23, 1938, Michelbacher and Ross, 1♂; 5 miles S. Miraflores, July 10, 1938, Michelbacher and Ross, 1♂; 5 miles W. San Bartolo, July 13, 1938, Michelbacher and Ross, 2♂♂, 2♀♀; San Ignacio, June 26, 1938, Michelbacher and Ross, 1♂, 1♀; 5 miles S. San Miguel, July 20, 1938, Michelbacher and Ross, 1♂.

Family **CALAMOCERATIDAE**

Notiomyia sagittosa Ross, new species

This species is closely related to both *N. mexicana* Banks and *N. ornata* Banks, from both of which it differs in its uniform drab color pattern. The male genitalia of all three species are strikingly similar in general outline; in details those of *N. sagittosa* differ from those of *N. mexicana* in lacking a horn-like development of the tenth tergite and from those of *N. ornata* in lacking wide lateral flanges on the tenth tergite.

Male. Length 9 mm.; antennae very long, attaining about 15 mm. Color a mixture of light orange and dark brown as follows: head mostly orange with dark areas mesad of eyes, palps and antennae dark brown, nearly black; thorax orange; meso- and metathorax brown; abdomen dusky orange; legs light brown, the two posterior pair darker and clothed beyond femora with dense black hair; wings dark brown, with indistinct stripes of silvery hairs along the base of M, Cu_2, and 1A. General structure typical for genus.

Genitalia as in figure 3. Ninth segment almost annular. Tenth tergite, figure 3B, with a sharp shoulder where it connects with ninth, below that

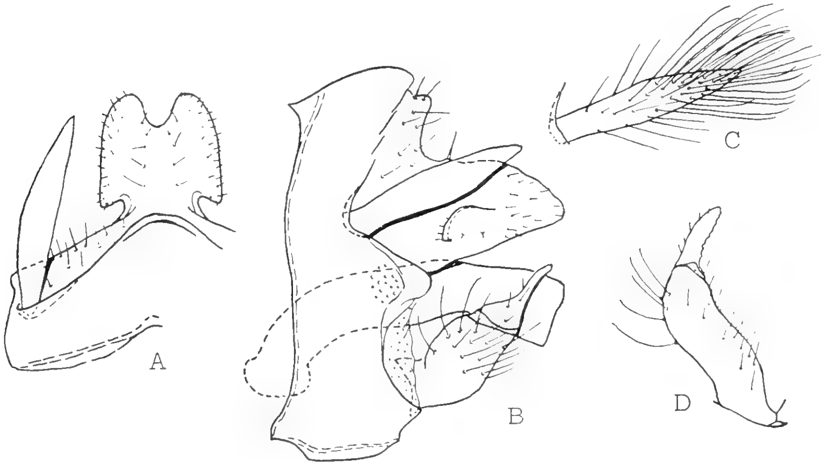

Fig. 3. *Notiomyia sagittosa*, new species; *A*, male genitalia, dorsal aspect; *B*, same, lateral aspect; *C*, cercus with normal setation; *D*, clasper, posterior aspect.

sloping into the large, deep apical portion. The dorsal aspect of this apical portion is excavated at apex and sharply constricted at base so that the extreme lateral margins form a flange, figure 3A. Cercus lanceolate, closed with abundant, long setae, figure 3C (the setae are omitted in figures 3A and 3B). Clasper, figure 3D, with distinct apical segment; basal segment sinuate and clothed with long lateral and short mesal setae; apical segment with lateral aspect bulbous at base, finger-like at apex, ventral aspect regular and with a serrate mesal margin. Aedeagus simple and tubular.

Holotype, male. **Todos Santos, Lower California, Mexico,** Nov. 10, 1941, Ross and Bohart. In the California Academy of Sciences.

Paratypes. Same data as for holotype, 3♂♂. Two deposited with the holotype and one in the collection of the Illinois Natural History Survey.

FAMILY LEPTOCERIDAE

Oecetis inconspicua (Walker)

Leptocerus inconspicuus WALKER, 1852, Cat. Neur. Brit. Mus., :71.

Setodes flaveolata HAGEN, 1861, Syn. Neur. N. Am., :282.

Setodes micans HAGEN, 1861, Syn. Neur. N. Am., :283.

Setodes sagitta HAGEN, 1861, Syn. Neur. N. Am., :284.

Oecetina parvula BANKS, 1899, Trans. Am. Ent. Soc., 25:215.

Oecetina flavida BANKS, 1899, Trans. Am. Ent. Soc., 25:216.

Oecetina floridana BANKS, 1899, Trans. Am. Ent. Soc., 25:216.

Oecetina inornata BANKS, 1907, Proc. Ent. Soc. Wash., 8:128.

Oecetina apicalis BANKS, 1907, Proc. Ent. Soc. Wash., 8:129.

Leptocerus incertus HAGEN *nec* Walker, 1861, Syn. Neur. N. Am., :278.

Oecetis incerta (HAGEN *nec* Walker). BETTEN, 1934[1], N. Y. St. Mus. Bull., 292:271.

Oecetis inconspicua (WALKER). MILNE, 1935, Stud. N. Am. Trich., 2: unnumbered page of corrections; BETTEN and MOSELY, 1940[2], Fr. Walker Types Trich., :67; ROSS, 1944[3], Ill. Nat. Hist. Surv. Bull., 23:242; DENNING, 1947[4], Ann. Ent. Soc. Am., 40:656; LEONARD and LEONARD, 1949, Occ. Pap. Mus. Zool., Univ. Mich., 522:24.

Type locality: Georgia.

Recorded distribution: Widespread over North America from central Canada to Mexico[3], and in West Indies[4].

New records: LOWER CALIFORNIA—Comondu, July 22, 1938, Michelbacher and Ross, 1♀.

[1,2] Extensive summaries to the literature are given in these papers.

Oecetis disjuncta (Banks)

Oecetina disjuncta BANKS, 1920, Bull. Mus. Comp. Zool., 64:351.

Oecetis disjuncta (BANKS). BETTEN, 1934, N. Y. St. Mus. Bull., 292:274; MILNE, 1935, St. N. Am. Trich., 1:17; ROSS, 1938, Psyche, 45:24; ROSS, 1944[1], Ill. Nat. Hist., Surv. Bull., 23:301.

Type locality: Arroyo Seco Canyon, San Gabriel Mts., Calif.

Recorded distribution: Western United States[1].

New records: LOWER CALIFORNIA—Rio Santo Domingo, Rancho San Antonio, 1,000 feet elev., May 24, 1937, H. J. Rayner, 2♂♂.

Leptocella sp.

A single male of this genus is in the collection. It belongs to the *L. texana* complex, but there is so much uncertainty regarding the identity of material in this portion of the genus that it seems advisable to refrain from placing a specific identification on the specimen. It was collected 5 miles S. Miraflores, July 10, 1938, Michelbacher and Ross.

FAMILY **SERICOSTOMATIDAE**

Sericostoma sp.

In Lower California several specimens were obtained belonging to the *S. griseolum* group. Further study is needed in this group before the various species segregates can be ascertained and the existing names applied to them. The data are as follows: Catavina, July 19, 1938, Michelbacher and Ross, 2♂♂; 17 miles S. Ensenada, June 14, 1938, Michelbacher and Ross, 8♀♀.

FAMILY **HELICOPSYCHIDAE**

Helicopsyche borealis (Hagen)

Notidobia borealis HAGEN, 1861, Syn. Neur. N. A., :271.

Helicopsyche californica BANKS, 1899, Trans. Am. Ent. Soc., 25:210.

Helicopsyche annulicornis BANKS, 1904, Proc. Ent. Soc. Wash., 6:212.

Helicopsyche borealis (HAGEN). BETTEN, 1934[1], N. Y. St. Mus. Bull., 292:417; MILNE, 1936, Studies N. Am. Trich., 3:115; ROSS, 1938, Psyche, 45:42; ROSS, 1944[2], Ill., Nat. Hist. Surv. Bull., 23:266, 288; LEONARD and LEONARD, 1949[3], Occ. Pap. Mus. Zool., Univ. Mich., 522:28.

Helicopsyche californicus BANKS. ROSS, 1938, Psyche, 45:42.

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[1] Contains extensive bibliography.

Type locality: St. Lawrence River, Canada.

Recorded distribution: Widely distributed over North America[1,2,3].

New records: Rio Santo Domingo, Rancho San Antonio, 1,000 feet elev., May 24, 1937, H. J. Rayner, 1♂.

Helicopsyche sp.

Three collections of this genus consist of a single female each. Specific characters are not yet established for the identification of this sex, so no further identification can be made at this time. The collections were made 17 miles S. of Ensenada, June 14, 1938, Michelbacher and Ross; at San Fernando, July 31, 1938, Michelbacher and Ross; and at Todos Santos, Nov. 10, 1941, Bohart and Ross.

Family **LEPIDOSTOMATIDAE**

Lepidostoma rhino Ross

Lepidostoma rhino Ross, 1946, Ann. Ent. Soc. Amer., 39:276.

Type locality: R. Santo Domingo, Rancho San Antonio, Lower California.

No additional material of this species has been collected.

PROCEEDINGS

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STUDIES IN THE MALACHIIDAE. III

BY

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INTRODUCTION

The primary purpose of the present paper is a revision of the genus *Attalus* Erichson, which has not been revised since Horn (1872) presented his synopsis of the family. However, in gathering together the material necessary for this revision, the collections of the entire family belonging to several institutions were carefully examined and, in the course of this work, which involved the identification of several thousand specimens, a number of undescribed species of other genera were discovered, variational and other noteworthy observations were made on already known species, and unrecorded distributional data were secured on many species. The present occasion is taken to describe these new species and to record these observations and data.

The institutions whose collections of Malachiidae have passed through my hands are The American Museum of Natural History, Cornell University, Ohio State University, University of Idaho, South Dakota State College, and the California Academy of Sciences *(Attalus)*. Several private collectors, notably Mr. J. W. Green and Mr. C. A. Frost, have loaned me their material in *Attalus* for study, and I have examined the Leconte and the Fall types in the family, at the Museum of Comparative Zoology, Cambridge, Massachusetts, which has enabled me to make positive identification of several species whose identity remained in some doubt after a perusal of the published literature.

I am indebted to numerous friends and correspondents for the loan or gift of valuable material, the furnishing of copies of unavailable descriptions, and other favors shown me in the course of these studies. Particularly I wish to thank the following: J. W. Green, C. A. Frost, W. S. Barr, Hugh Leech, Mont A. Cazier, Henry Dietrich, J. N. Knull, P. J. Darlington, H. C. Severin, and W. R. Sweader.

The different genera and species, insofar as they are mentioned in the present paper, will be considered in the usual catalogue order.

TAXONOMY

Collops Erichson

Since the publication of Fall's revision of this genus (1912), only two new species have been described, *C. oklahomensis* Brown (1928) and *C. bridgeri* Tanner (1936). The five species described herewith bring the number to seven. As all of these can easily be interpolated in Fall's excellent, although rather difficult-to-use key, it does not appear that a new key to the genus is necessary at the present time. The difficulty mentioned arises, not through any inability of Fall to draw up an adequate key, but through the fact that many of the species are so variable that individual specimens may be placed with equal propriety in more than one primary division of the key. In fact, the more one scrutinizes Fall's work and has occasion to make use of it, the more one is impressed with the keenness of his powers of observation and the excellence of his judgment.

Collops bipunctatus Say

A series of seven specimens, from Mexico City, D. F., and Atzcapolzalco (from its Aztec name probably also located in the Distrito Federal) present such a different appearance from the specimens of *C. bipunctatus* taken in the United States that one is tempted to describe them as a geographic race or subspecies. These specimens have the thoracic spots markedly dilated, so as to occupy almost one-half of the entire prothoracic surface. The spots are roughly triangular, with the median edges parallel and narrowly separated by a median red line. They almost attain the anterior thoracic margin and extend about two-thirds the distance from the center to the basal and lateral margins, the lateral edges of the spots roughly paralleling the lateral thoracic margins. The legs and antennae are entirely black, except the first antennal segment and the upper surface of the second segment, in both sexes. In the course of the past two years I have examined probably a thousand specimens of *C. bipunctatus,* from eleven western states. In a small percentage of these, the color of the legs and antennae approaches that seen in the Mexican specimens, but in none of them are the thoracic spots, which are normally a pair of small dots, as indicated by the specific name, more than slightly dilated. This form probably deserves a separate name, but in the absence of specimens from the extensive range of territory between Arizona and Mexico City, it is possible that it represents only the extreme of a variation which occurs throughout the southern portion of the range of the species. An inspection of the ''long series'' in the British Museum, which Champion (1914) reports from Durango, would probably tell whether the variation is continuous or discontinuous.

Collops flavicinctus Fall

In Fall's unique type and in most of the other specimens that I have seen, about fifteen in all, the thorax is black, very narrowly margined with yellow. I have a female specimen from Wickenburg, Arizona, in which the thorax is entirely rufotestaceous, and a male from the Davis Mountains, Texas, in which the thorax is pale, with a broad median black stripe, occupying the middle third. In the same specimen the elytral vittae, which are brighter blue than usual, extend clear to the base, whereas in all the others the pale lateral and sutural margins are continuous across the base; the legs are entirely black, except the anterior femora, there is a piceous spot on the first antennal segment, and the pale frontal margin of the head is narrower than normal and slightly trilobed.

Collops vittatus (Say)

Fall (1912) states that, in his experience, the elytral vittae are never completely interrupted in this species. I have a male specimen from Hurricane, Utah, which agrees in every other respect with typical *C. vittatus* and which has the elytral vittae completely and broadly interrupted.

Collops histrio Erichson

It is perhaps worthwhile to again call attention to the extreme variability of this species, both as to color and as to the sculpturation of the prothorax. In a series of ten specimens from Oak Creek Canyon, Arizona, all but three have the elytra entirely black, with the posterior three-fourths of the suture or less and a small wedge-shaped spot near the middle of the lateral margin yellow. In the three exceptions, the elytral spots are very narrowly and incompletely divided. In all of them, the thorax is very shining in the middle third and is dull, minutely rugose, and alutaceous in the lateral thirds. I almost repeated Fall's error, when he described *C. argutus* (1901), by calling this form a new species. Owing to the constancy of the above characters in this locality, it might be entitled to rank as a subspecies, with the advantage of enabling other workers to identify it more easily, but I prefer the more conservative course of considering it as a mere local variation.

Collops tibialis Schaeffer

A male from Nogales, Arizona, has the two basal segments of the antennae and the abdomen entirely pale; the tibiae, tarsi, and anterior femora red; and the middle and posterior femora black. The elytral spots are black, rather than blue. This specimen was sent me by the late Mr. Nunenmacher, under the name *C. spretus* Fall, which I am unable to find in the literature and which is apparently a manuscript name. I believe that it is only an unusually pale form of *C. tibialis,* with which it agrees in all other respects.

Collops bridgeri Tanner

This species was described by Dr. Tanner (1936) from a unique male from Wyoming. The female, to my knowledge, has never been described. Two females, collected by Dr. H. C. Severin at Placid Lake, Montana, agree so well with Tanner's description that I have no doubt as to their identity. One of these is chosen as the allotype and described herewith.

Female. Agrees with the description of the male in all respects, except the following. The first two antennal segments are black on the dorsal surface and rufotestaceous beneath. Segments two to seven, inclusive, are moderately and decreasingly serrate, while numbers seven to ten are practically cylindrical. The elytra are oval, widest in the posterior third; the humeri distinctly narrower than the base of the thorax, the wings shorter than the elytra. The last sternite is deeply and longitudinally impressed in the midline. Length 3.2 mm. from anterior edge of thorax to elytral tips.

The single parallotype has the two basal antennal segments entirely rufotestaceous, except for the dorsal surface of the proximal half of the first segment, and the anterior margin of the clypeus is narrowly pale. The last sternite is apparently completely divided by the longitudinal impression.

Allotype, female, "Placid Lake, Mont., Aug. 8, 1947. H. C. Severin, Coll.," returned to Dr. Severin at South Dakota State College. One parallotype, same data, in author's collection.

A male, from Hanna, South Dakota, 2.8 mm. long, is referred here, although the elytra are dark metallic blue, instead of black. Compared with the two females from Montana, the elytral punctuation is more dense and the decumbent pubescence is light brown instead of white. These slight differences, however, do not appear to justify its description as a new species.

Collops arizonensis Marshall, new species

Male. Elongate-oval, elytra slightly widened posteriorly, conjointly rounded. Black, elytra metallic blue, with the central portion of the lateral margin faintly rufescent, a broad margin occupying nearly the lateral third on each side of the prothorax, the entire prosternum, the clypeus and labrum, the tips of all the palpi and maxillae, the entire first antennal segment, the upper margin and process of the second antennal segment, and all the abdominal segments testaceous. *Head* only moderately shining, very finely and densely punctured and clothed with pale decumbent pubescence and numerous long, black, erect setae, which arise from larger punctures. *Antennae* moderately serrate, the first segment roughly triangular when viewed from the front, the anterior surface conical and prominent, coming to a distinct point, the posterior surface not impressed or sinuate; the second segment viewed from beneath quadrate, about as long as wide, the depression on the upper surface divided into two unequal fossae, the edge of the proximal and larger one of which is pale; the process moderately developed, about as long as the segment itself and clinging closely to the anterior edge of the depression; the tooth which is usually seen on the anterior aspect, near the base of the process, is obtuse and rounded at the tip. *Prothorax* transversely oval, 1.6 times wider than long, slightly narrowed anteriorly, all the angles broadly rounded; more shining than the head, the punctures and decumbent pubescence extremely fine, the black setae numerous and prominent. *Elytra* rather dull, the punctures moderate in size and very dense, in part coalescing, the smooth spaces between the punctures much less than the diameter of the latter, the elytral surface slightly uneven but not definitely tuberculate, rather densely clothed with pale, prostrate pubescence and erect, black setae. *Legs* black, the tibiae and tarsi in part rufescent. *Abdominal segments* yellow, with a lateral piceous spot on either side of each segment, the spots decreasing in size posteriorly. The last sternite is slightly shorter than the pygidium, broadly notched at the tip, carinate in the midline and depressed each side of the carina.

Female. Similar to the male in all respects except the following: Slightly broader in proportion to the length; median black thoracic stripe slightly wider; basal antennal segment pale, with a piceous spot on the anterior face; second segment black, with the posterior edge pale; abdomen more heavily maculate with black. The last sternite is black, completely divided in the midline, forming two lateral lobes.

Length, male and female, 4.5 mm.

Holotype, male,; allotype, female; and two female paratypes, "**Chiricahua Mts., Ariz.,** June. D. K. Duncan," in the author's collection.

The paratypes show no variations of any consequence. In one of them, the abdomen is more heavily maculate with black than in the allotype and might be described as black, with the central portion and margins of the segments yellow.

This is probably the form that Fall (1912) mentioned in his remarks under *C. marginicollis* Leconte, when he stated: "Two females from Southern Arizona submitted by Mr. Schaeffer and one from the same region in my own collection also have entirely black legs but are otherwise scarcely separable. These agree well enough with the short description of *C. aulicus* Erichson, a Mexican species, and may be that, but in the absence of males and of authentic examples of *C. aulicus,* nothing more definite can be said.'' I have one male of the present species and also one male of *C. aulicus* from Atzcapolzalco, Mexico, which is as authentic as it could well be unless it had been actually compared with Erichson's type.

The present species differs from *C. marginicollis,* not only in the all black legs and almost all black antennae, but in the fact that the elytra are not distinctly tuberculate, as in that species. From *C. aulicus,* which it resembles in general coloration and appearance, it differs by the elytra in *C. aulicus* being of a more brilliant blue color, with the femora blue-black and, more importantly, by the structure of the antennae. The basal segment, in *C. aulicus,* is not triangular or conical in front; it is elongate-cylindrical viewed from the front, and the upper surface is projected backward into a broad, flat wedge, which ends in a right angled tooth at its distal end. The second segment in *C. aulicus* has the tooth on the anterior face much more pronounced and the process much longer, erect and angulated in the middle.

Collops simplex Marshall, new species

Male. Oblong oval, rather depressed for the genus, scarcely widened posteriorly; head, prothorax, and upper surface of first antennal segment black, elytra blackish violaceous, antennae, labrum, tips of mandibles, palpi, entire ventral surface, and legs piceous; under surface of first antennal segment, mandibles, and tarsi testaceous to piceotestaceous. Entire upper surface alutaceous, lower surface shining. *Head* with the front flattened, faintly and irregularly impressed, densely and confluently punctured, the punctures sparser on the occiput; pubescence practically invisible. *Antennae* 10-segmented, stout, feebly serrate, rather long, passing the thorax by about two segments, finely pubescent; the first segment elongate triangular, rounded on the outer end, the second strongly and semi-circularly dilated on its anterior border (the same border as the serrations on the other segments), its base constricted, its upper surface not excavated as is usual in the genus. *Prothorax* quadrate-transverse, 1.5 times as wide as long, all the angles broadly rounded, the sides parallel, the posterior angles slightly and rugosely impressed, surface more densely alutaceous than on the head and elytra, punctuation extremely fine and sparse, pubescence as on the head, with a few short erect black setae near the anterior angles. *Elytra* faintly scabrous, punctures and pale pubescence extremely fine and sparse, with a scattering of short, erect black hairs, also visible only in an oblique light. *Under surface* and legs with fine, sparse, pale pubescence. Last ventral segment as long as the pygidium and divided into the usual two lateral lobes. Pygidium triangular, with the tip rounded and very feebly emarginate. Anterior tarsi definitely 4-segmented.

Length, 3.3 mm. Female unknown.

Holotype, male, "**Tracy, California** VII–13–37. E. S. Ross, Collector," in the collection of the California Academy of Sciences.

No paratypes.

This species may be known at once from all our other members of the genus *Collops* by the simply-dilated second antennal segment of the male. This segment is markedly dilated, but not excavated on the upper surface, as in the other species. The question arises as to whether to leave it in *Collops* or to erect a new genus for it. As a precedent for the former course, I quote Abeille de Perrin (1891) who, in defining the genus *Collops,* states: "Antennes de dix articles apparents, le 2^{e} *generalment* de forme monstrueuse chez les males." He then describes *Collops cinctus* Gebler, stating: "2^{e} (article) plus long, tres gros, irregulierement triangulaire; *convexe par dessus,* deprime par dessous" (the italics are mine).

Collops pallipes Marshall, new species

Female. Elongate oblong, elytra slightly widened posteriorly, tricolored above, head black above the level of the lower border of the eyes, thorax testaceous, elytra brilliant metallic blue; entire epistoma and trilobed frontal margin testaceous, the central lobe semicircular; antennae testaceous, the outer segments slightly infuscate; under surface, including legs, testaceous, except for the head posterior to the base of the mentum, the meso- and metasterna, the posterior coxae and trochanters, which are piceous black. *Head* shining, bi-impressed between the eyes, very finely and sparsely punctate across the occiput, more densely on the front; pubescence sparse, pale, decumbent, with a few scattered erect, black setae. *Antennae* with the second segment distinctly swollen and about twice as long as the succeeding segments, which are faintly serrate. *Prothorax* transversely oval, about 1.5 times as wide as long, the angles all strongly and evenly rounded, the middle third of the base truncate; surface shining, practically impunctate and glabrous, except for scattered erect, black setae, which arise from minute punctures. *Elytra* shining, non-tuberculate, the punctures dense and moderately coarse, the intervals between the punctures, on the average, about the diameter of the latter, the pale semi-decumbent pubescence rather sparse, the numerous, rather short, erect, black setae evenly distributed. Wings fully developed. Under surface sparsely clothed with pale pubescence, the legs uniformly rufotestaceous in color. Last abdominal segment divided in the midline, forming two lateral lobes or flaps.

Length, 4.0 mm. Male unknown.

Holotype, female, "**Brownsville, Texas** VIII–8–37. D. J. and J. N. Knull, Collrs." The unique type specimen in being returned to Dr. Knull at Ohio State University.

This species does not run to anything in Fall's (1912) key, because of the combination of unicolorous elytra, fully developed wings, pale prothorax, and uniformly pale legs. Superficially, it most nearly resembles *C. tricolor* Say, which has all black legs. Likewise, it cannot be referred to any species in Champion's (1914) key to the Mexican species for the same reason, regardless of what proves to be the structure of the male antennae.

Collops knulli Marshall, new species

Male. Elongate oval, elytra slightly widened posteriorly, wings fully developed. Testaceous, head in large part black, elytra quadrimaculate, with large, narrowly confluent, blue-black spots. *Head* with the epistoma and the anterior portion of the front, almost to the level of the lower border of the eyes, rufotestaceous, the line of demarcation between this and the black portion of the head indefinite; surface only moderately shining, finely and densely punctulate, with fine, dense, pale pubescence; lower portion of the front slightly impressed on either side of the midline. *Antennae* testaceous, the outer eight segments slightly infuscate, scarcely serrate, the first segment elongate triangular, about twice as long as broad, not sinuate or excavate posteriorly, smoothly convex anteriorly; the second segment oval viewed from beneath, with the posterior border somewhat produced, longer than wide, the process long and slender, angulate in the middle and black in the distal half; the tooth on the upper edge of the anterior face blunt and poorly developed. *Prothorax* transversely oval, about 1.5 times as wide as long, the angles all rounded, the posterior more broadly so than the anterior, shining, the punctures extremely fine, the pubescence similar to that on the head, but sparser. *Elytra* moderately shining, the punctures very fine but dense, the pubescence pale and much more dense than on related species, the surface with numerous, evenly distributed, erect, black setae, as on the head and prothorax. The anterior spots are continuous across the base and the posterior attain the lateral margin near the apex. *Underside* testaceous, including all the legs, the meso- and metasterna piceous and the abdominal segments washed with piceous except on their margins. The underside is strongly pubescent, unusually so for the genus, the pubescence on the tibiae practically obscuring the surface. Last abdominal segment acutely emarginate at the apex, the surface of the segment unmodified.

Length, 3.0 mm. Female unknown.

Holotype, male, "**Gillespie Co., Tex.** V–7–46. D. J. and J. N. Knull." The unique holotype is being returned to Dr. Knull at Ohio State University.

This species runs to *C. similis* Schaeffer in Fall's (1912) key, but *C.*

similis is a larger species, the elytra are much more coarsely punctured, the legs are bicolored, and the pubescence is much sparser. In Champion's (1914) key to the Mexican and Central American species it runs to *C. histrionicus* Champion. I have this species from Guatemala. It is also a larger species, the elytra are much more coarsely punctured, the legs are black, and the process of the second antennal segment is much heavier and entirely pale.

Collops peninsularis Marshall, new species

Male. Oblong oval, very slightly widened posteriorly; rufotestaceous, head black to the fronto-clypeal suture, elytra with two elongate bluish spots on each, tips of mandibles and palpi and entire metasternum piceous, legs bicolored. *Head* of usual size and shape, surface shining, very finely punctulate, the punctules denser on the front, where the yellow pubescence is decumbent and silky in appearance. The entire upper surface, including head, thorax, and elytra, is generously provided with long, erect, black setae, rather evenly distributed. *Antennae* of moderate length, testaceous, strongly serrate, the first segment, viewed from above, triangular, flattened, twice as long as wide, the anterior edge moderately convex and angulate at the distal end; the second segment large, quadrate, 1.4 times wider than long, the process or appendix short and thick, visible only from above, the excavated upper surface divided into two unequal compartments by a transverse partition, much nearer to the distal end of the segment. *Prothorax* transverse oval, 1.5 times wider than long, the posterior margin faintly sinuate, the anterior slightly produced, the basal marginal bead and posterior angles reflexed; the surface shining, punctuation very fine and sparse, except in the lateral fourths, where it is denser and the surface less shining; pubescence yellow, semi-decumbent, it and the erect black setae rather conspicuous. *Elytra* less shining, finely and densely punctured, the pale pubescence semi-erect and prominent, scutellum black, the basal spots covering the humeri, but not reaching the scutellum; the humeral umbone less densely punctured and strongly shining; the subapical spots not reaching any of the elytral margins. Pygidium broadly truncate, piceous, except for basal and lateral margins and a pale central streak. *Under surface* finely and densely punctate and pubescent. Front and middle legs testaceous, except for the coxae and proximal ends of the tibiae, which are piceotestaceous; hind legs piceous, except for the proximal ends of the femora and the tarsi, which are testaceous.

Female. Similar to the male, except for the sexual characters. The antennae, beyond the first three segments, are piceous, and the legs are darker than in the male, being piceous or piceotestaceous, except for the proximal portions of the femora. The last sternite is piceous, except for the margins, and is depressed in the midline, the entire lateral halves of the segment forming a V-shaped trough.

Length, male 5.0 mm., female 4.0 mm.

Holotype, male and allotype, female, collected by Michelbacher and Ross, "**20 mi. n. Comundu, L. Cal.** VII–2–38," in the collection of the California Academy of Sciences. No paratypes.

The species runs to *C. confluens* Leconte in Fall's (1912) key and to *C. femoratus* Schaeffer in Champion's (1914) key. From *C. confluens* it may be separated by its larger size and much finer punctuation. It more nearly resembles *C. femoratus,* which, however, also has the elytra more coarsely punctured, the antennae much less strongly serrate and the second antennal segment differently shaped and not wider than long.

Trophimus Horn

Trophimus aeneipennis Horn

The males of this species show secondary sexual modifications of the ventral segments which have not been observed in any other North American representative of the family and from which they can be more easily identified than by counting the protarsal segments, which in mounted specimens are often difficult to see clearly. These characters are not mentioned by Horn in his original description and have not, so far as I know, been previously noted in the literature. The third sternite is black, heavily chitinized and projects over the fourth in an obtusely angled lobe, whose free edge is thickly and finely setose. The last three segments are pale, the fourth very narrow, practically concealed by the above-mentioned lobe, the fifth wider and occupied almost entirely by two large, shallow pits or depressions, one on either side of the midline. The species superficially resembles *Tanaops mimus* Fall rather closely and has been found mixed with the latter in collections.

Attalusinus Leng

Attalusinus submarginatus Leconte

A female of this very rare species, from Yuma, Arizona, has been compared by the author with Leconte's unique female type at the Museum of Comparative Zoology and found to be identical with the latter. The color is aeneous black, with the thorax obsoletely rufescent, as described by Leconte. The specimens in the National Museum under this name, which were mentioned in a previous paper (Marshall, 1949) are all much paler in color, a yellowish testaceous, as I recall them, and larger. Mr. Barber is probably correct in his statement that none of the three species in that collection is *A. submarginatus.* I hope to be able to describe them in a subsequent paper.

Tanaops Leconte

Tanaops complex Fall

A series of fourteen specimens of this rare species, from the Chiricahua Mountains, Arizona, all have the thorax black, except two specimens, one of which has an all red thorax, as did the pair from which Fall (1917) described the species, and the other of which has the posterior angles red. The color of the thorax is of no value in separating the closely allied *T. mimus, T. coelestinus,* and *T. complex.* These specimens all show a shining, denuded spot on each side of the prothorax, of variable size, near the posterior angles, which is obviously a characteristic of the species. This does not show up nearly so plainly in the specimen with the red thorax, which is probably the reason that Fall overlooked it in his two specimens.

Tanaops spinifer Fall

The acquisition of new material, from the Huachucha Mountains, Arizona, has caused me to reverse my identification of two species, this one and *T. terminalis* Fall. The species which I had identified as *T. spinifer* was represented in my collection by four males and four females, whereas *T. terminalis,* so called, was represented by only a single female. Additional males and females, three each, clear up the ambiguity created by Fall (1917) when he stated in his key that the front *coxae* of *T. spinifer* were spined and in his description that the front *trochanters* were spined. The recently acquired males have the front *trochanters* terminated distally in a prominent acute spine, which is easily observed. The remarks which I made concerning *T. spinifer* in the first number of these studies (Marshall, 1946) apply to the species which I now identify as *T. terminalis.*

Tanaops terminalis Fall

A series of ten specimens, four males and six females, from the Chiricahua Mountains and Catalina Mountains, Arizona, correspond in all important features with Fall's (1917) short description of that species, but is obviously distinct from the species just mentioned, which I have identified as *T. terminalis,* from the Grand Canyon region. It would serve no purpose to describe the differences here, since it would be impossible to be sure which of the two species is really *T. terminalis* without an opportunity to reexamine Fall's type. The same remarks apply with equal force to a single female from Banning, California.

Anthocomus Erichson

The species formerly listed under the genera *Malachius* and *Microlipus,* excepting *Malachius aeneus* Linnaeus, have been placed in the genus *Antho-*

comus (Marshall, 1949), and the following two species, formerly in *Malachius,* are therefore considered under *Anthocomus.*

Anthocomus biguttulus (Horn)

The females, like those of *A. mixtus* (Horn), at times occur without any apical pale areas. Of five specimens, collected at Independence, California, two have faint apical pale areas and three no trace of such areas.

Anthocomus directus Fall

A series of about thirty specimens, collected at Keen Camp, Riverside County, California, by D. J. and J. N. Knull, correspond to Fall's (1901) description of this species in every particular except the color of the prothorax, which in the type has the sides ''broadly yellow.'' A pair from this series, male and female, have been compared by the author with Fall's types in the Museum of Comparative Zoology, at Harvard University. In all of the specimens of the series the thorax is wholly black, except in one male, in which the hind angles are rather broadly yellow, as noted by Fall in ''other specimens'' which he stated were ''quite surely the same thing.'' Since the color of the thorax is notoriously variable in this family, one would not be justified in giving a new name to this dark form. The tips of the elytral appendages, which are closely applied to the inferior surface of the elytral tips, extend beyond the latter to a variable degree and, in most cases, are thickened and black.

Anthocomus ventralis Horn

Examination of the two cotypes, one male and one female, in the Ulke collection, now in the Carnegie Museum in Pittsburgh, which were kindly sent to me for study by Dr. Walter R. Sweader, has enabled me to resolve the doubts as to the identity of this species which were expressed in a previous paper (Marshall, 1949). The Ulke collection contains three specimens labeled *Anthocomus ventralis,* the two cotypes, simply labeled ''Ariz.,'' and a male of a species of *Tanaops,* from Texas. Horn gives no description of the male elytral appendages in *A. ventralis* and does not even state the sex of his two cotypes. The male has the elytra appendiculate as in *A. erichsoni* Leconte, and a careful comparison of the male type with males of *A. erichsoni* from New York and Kentucky convinces me that *A. ventralis* is not specifically distinct from *A. erichsoni* and is at most entitled to rank as a subspecies of the latter.

The only distinguishing characters that Horn gives for *A. ventralis* are the entirely yellow thorax and abdomen, which is not strictly true in either case. The prothorax of the male cotype shows two faint piceous spots in the midline, one almost adjacent to the basal margin and the other, slightly larger, somewhat more remote from the anterior margin. I have a female of *A. erichsoni,* from Kentucky, which has the usual dark thoracic stripe almost as much reduced. Also, the pair of piceous spots on each abdominal segment, which in *A. erichsoni* occupy the greater portion of the segment, are faintly discernible in the male type of *A. ventralis.* The female type, as in *A. erichsoni,* has the abdomen rufotestaceous, with the last sternite piceous. The modifications of the elytral tips in the two forms, which are quite unusual and distinctive, appear to be identical down to the smallest details, such as the border of stiff hairs and the beading of the inner margin and tip of the broad, triangular appendix on the under side.

Anthocomus barri Marshall, new species

Male. Elongate, parallel, the elytra scarcely widened posteriorly. Black, the thorax faintly aeneous, the elytra with a faint bluish tinge. Narrow margin of prothorax, excepting the base, testaceous, this margin wider at the posterior angles. Entire surface moderately shining. *Head* with a central and two lateral impressions, the former rounded and located at the junction of front and occiput, the latter elongate and on the front; surface minutely punctulate and pubescent. *Antennae* pectinate and more strongly pubescent, the pectination of segment six exactly as long as the segment itself, when measured on the outer edge of the angulation, that of segment seven three-fourths the length of the segment, the pectinations of the other segments gradually decreasing toward either end of the antenna; pectinations elongate triangular in outline, evenly tapering to an acute point. Antennae long, reaching about the middle of the elytra. *Prothorax* quadrate, one-fifth wider than long, the sides slightly converging anteriorly, the apex somewhat produced, the posterior angles and base rather strongly reflexed, the surface extremely finely punctulate and pubescent, about as on the head. *Elytra* scabrous, punctures not discernible, the pubescence extremely short, fine, pale, and inconspicuous. Apex of each elytron produced into two teeth, the larger sutural, acutely pointed, grey in color and of thinner texture than the balance of the elytron, the smaller blunt and separated from the other by a small semicircular notch. Elytral appendices grey, oval in outline, not emarginate, extending beyond the elytral tips to a moderate degree and with a transverse anteapical ridge or thickening. The processes rather slender, not contorted, slightly shorter than the appendices, which, together with the sutural tooth, are covered with a fine, white silky pubescence. The long axes of the appendices and processes converge posteriorly. *Underside* entirely black, the legs and sterna finely, densely punctate and with a white pubescence, which is denser than that on the upper surface. Abdominal segments more sparsely punctured and pubescent, the terminal segment deeply and acutely emarginate, with a depression on either side of the emargination; the pygidium squarely truncate and with rather dense, long, white pubescence. Sheath of the adeagus long, black, cylindrical, bivalved at the tip.

Female. Similar to the male, except in the following respects. The thorax and elytra are more conspicuously pubescent; the pale thoracic margin disappears anteriorly, as well as posteriorly; the antennae are moderately serrate and shorter; the elytral tips are pale at the sutural angle and the last sternite is entire and convex.

Length, male and female, 3.5 mm.

Holotype, male and allotype, female, "**McKittrick, Cal.** III–21–40 W. F. Barr." Types to be deposited with the California Academy of Sciences, San Francisco, at request of Dr. Barr. Six female paratypes, two with the same data as the types, four from Clear Creek, Cuyama Valley, California, III–22 and 23–40. Paratypes in the author's collection and in that of Dr. Barr.

The only variation noted in the paratypes concerns the amount of pale coloration of the prothoracic margins and the elytral apices. In two specimens, the lateral pale margins are much wider than in either of the types, whereas in one the pale color is confined to the posterior angles. The pale elytral tips are smaller in some specimens than in the allotype, and in one are so small as to justify the assumption that, in all probability, females occur with the elytra entirely black.

This species runs to *A. theveneti* Horn in my recent table of *Anthocomus* (Marshall, 1949). There are specimens of *A. theveneti* in my collection identified by both Fall and Blaisdell. It is a larger species, 5 mm. long, the elytra are more definitely blue, the prothorax is rufous with a large black discal spot and the elytral appendages are entirely different, in that the prolongations of the elytral apices proper are longer and rounded at the tips, the appendages are deeply emarginate at their tips, and the processes are heavier and longer, projecting well beyond the tips of the appendages.

Anthocomus atratus Marshall, new species

Male. Elongate, oblong, parallel, the elytra not perceptibly widened behind. Color uniformly black, without metallic luster, entire surface faintly shining, somewhat alutaceous. *Head* faintly impressed between the eyes, with a small rounded central impression and two elongate lateral impressions, sparsely and minutely punctulate and pubescent. *Antennae* pectinate, reaching to about the middle of the elytra, the pectinations triangular, sharply pointed, those on the intermediate segments longest and slightly shorter than the length of the segment. *Prothorax* quadrate transverse, 1.4 times wider than long, the sides parallel, the apex slightly produced, all the angles broadly rounded, the posterior angles and base moderately reflexed, punctuation and pubescence as on the head. *Elytra* very scabrous, much of the rugosity taking the form of fine, wavy transverse lines, the punctures not discernible in the roughened surface, the decumbent pubescence very fine, white and inconspicuous. There is a minute tooth at the sutural angle of each elytral apex and a simple appendage, black, broader than long, with an entire, broadly rounded edge, that projects slightly beyond the apex of the elytron. *Underside* slightly more shining than the upper, with sparser pubescence, except for the legs. The last sternite is shorter than the pygidium and completely divided into two pincer-like lobes with an oval opening between them for the adeagus. Pygidium quadrate, with sides parallel and apex truncate, apical angles narrowly rounded and apex shallowly emarginate in the center.

Female. Similar to the male, except in the following respects. Antennae shorter and moderately serrate. Posterior angles of prothorax narrowly testaceous. Elytral tips unmodified. Abdominal segments piceous, the terminal segment broader and shorter than usual, slightly shorter than the pygidium, tumid just behind the anterior margin, the tip broadly rounded, with a minute notch in the center. Pygidium quadrate, the sides slightly sinuate and converging posteriorly, the apex truncate and shallowly emarginate in the center.

Length, male 3.0 mm., female 3.5 mm.

Holotype, male, and allotype, female, "**Walker Pass, Kern Co., Cal.** IV–3–42. W. F. Barr, Collector." Types to be deposited with the California Academy of Sciences, at the request of Dr. Barr. Described from a single pair.

The species runs to *A. directus* (Fall) in my key to the genus (Marshall, 1949), but in size and color it more nearly resembles *A. nigritus* (Fall). *Anthocomus directus* is a larger species, the elytra have a definitely greenish color and are not so scabrous, the antennal pectinations are much longer and are rounded or spatulate at the tips and the elytral appendages are longer than wide, more projecting and narrowly rounded at the tips; the basal portion of the appendage is pale, the terminal portion thickened and black. *Anthocomus nigritus* is at once separated by the fact that the elytra of the males are not appendiculate; the females may be recognized by their more shining, scarcely scabrous elytra.

Two other undescribed species in this genus are represented only by females, and they will not be described until corresponding males are forthcoming, as they could not be identified by any known key.

Pseudebaeus Horn

Pseudebaeus apicalis Horn

Pseudebaeus oblitus Leconte (new synonymy).

A series of specimens of *P. oblitus,* from Graybeard Mountains, North Carolina, contains several males whose prothoraces are paler, in varying degree, than is the case in typical *P. oblitus.* In one of these the prothorax is testaceous, with the anterior one-fourth piceous, the dark color extending posteriorly in a median stripe to the base and in two lateral lobes about two-thirds the distance to the base. It would be but a short step from this to the coloration described by Say for *P. apicalis:* "thorax sanguineous, dusky on the anterior margin." The color of the prothorax is the only distinguishing character between the two species given by Horn (1872), and an examination of the original descriptions fails to disclose any other differential characters. I am forced to conclude that *P. oblitus* is merely a dark color phase of *P. apicalis,* which name has priority, possibly entitled to rank as a color variety, but not as a distinct species.

Nodopus Marshall, new genus

Antennae 11-segmented, feebly serrate, inserted at the sides of the frontal margin, contiguous to the clypeal suture; clypeus transverse, short, membranous anteriorly; labrum transverse, as long as the clypeus, quadrate, the tip truncate, the angles rounded; maxillary palpi 4-segmented, the first segment very short, the second and third equal, the fourth elongate, acuminate; labial palpi very small, only two segments visible; ligula membranous, rather deeply retracted into the oral cavity; mandibles bifid at the tip; head short, eyes prominent; thorax quadrate, transverse; elytra long, covering the abdomen, the tips simple in both sexes; all the tarsi 5-segmented, the first segment of the male protarsi with a rounded projection on the inner side, almost as large as the segment itself.

The genotype is *N. caviceps,* new species.

The following modification of my recently published key to the genera (Marshall, 1949) is necessary in order to show the relation of this genus to neighboring genera:

9. Male protarsi unmodified 10
Male protarsi with either the first or the second segment modified 11

10. Elytral tips of male prolonged and with small cup-shaped process extending upward from the tip of each elytron .... *Pseudebaeus*
Male elytra modified or not; if so, the tips are split horizontally with a variously shaped process below the plane of the elytra .... *Anthocomus*

11. First segment of male protarsi with a rounded protuberance on the inner side .... *Nodopus*

    Second segment of male protarsi prolonged in a lobe over the third........ 12

12. Form elongate; male antennae pectinate........*Acletus*

    Form relatively broad, antennae never more than moderately serrate....*Attalus*

Nodopus caviceps Marshall, new species

Male. Elongate, oblong, slightly widened posteriorly. Black, the clypeus, antennal foveae, under surface of first three antennal segments, prothorax except for a central black spot, genae and mandibles yellowish testaceous; labrum, palpi, tips of mandibles, antennae and all the tibiae and tarsi piceous, the tibiae becoming testaceous toward their proximal ends. *Head* short, the eyes quite prominent, the frontal surface strongly depressed or excavated on either side of the midline and as far as the eyes, leaving a sharp median carina that fades out anteriorly. The depressed areas terminate posteriorly in a bisinuate ridge, that starts at the posterior border of each eye and joins the median carina at the junction of the frons and occiput, forming a prominent, sharp tubercle at this point. The depressed areas, which occupy at least one-half the dorsal surface of the head, are glabrous and impunctate; the rest of the head shows fine punctures, becoming aciculate on the occiput, and a fine, decumbent, pale pubescence. *Antennae* long, reaching almost the middle of the elytra, feebly serrate. The upper distal angle of the first segment, viewed from beneath, is prominent and the second segment is deeply sinuate just distal to this prominence. The labrum is prominent and is bent down over the mandibles in front, concealing their tips. *Prothorax* quadrate, 1.5 times wider than long, the sides slightly converging posteriorly, all the angles rounded, the base and posterior angles rather strongly reflexed; surface moderately shining, very finely punctulate and with pale pubescence. The discal black spot is anteriorly placed and fades out toward the base. *Elytra* moderately shining, densely and finely punctulate and pubescent, the decumbent pubescence white and dense, with no erect setae present. *Under surface* black, except for the narrow yellow prosternum, mesosternal epimera and central membranous portions of the abdominal segments; together with the legs, very finely punctured and pubescent. First segment of the male protarsi with the rounded protuberance characteristic of the genus. Pygidium large, quadrangular, the sides converging posteriorly, the apex truncate, with the angles rounded; the surface feebly impressed in the midline and covered with sparse, long, pale pubescence. Last sternite shorter than the pygidium, deeply and acutely emarginate at the tip; the adeagus with the usual cylindrical sheath split at the tip to form a short dorsal and a longer ventral lobe.

Female. Similar to the male, except as follows. Antennae shorter and scarcely serrate; head and anterior tarsi unmodified; labrum shorter, exposing the mandibles; clypeal suture sinuate in the middle; clypeus, labrum, genae, mouth parts and legs uniformly piceous; black discal spot on pronotum larger, forming a wide median stripe, which reaches the apical, but not the basal, margin; pygidium similar to that of male, but more narrowed toward the tip and not impressed; last sternite entire, almost as long as the pygidium.

Length, male 2.3 mm.; female 2.6 mm.

Holotype, male and allotype, female, collected by Dr. H. Dietrich, at **Lucedale, Mississippi** III–10–1930; in the collection of Cornell University. No paratypes.

If the characteristic modification of the male protarsi should escape notice, this species would probably be mistaken for *Attalus tuberculifrons* Fall, as was done at first by the author. I have examined the unique male type of *A. tuberculifrons,* in the Museum of Comparative Zoology, and made the following notes: "The frontal tubercle is rounded and is formed by two depressions, which do not extend up and behind the eyes, as in *N. caviceps.* The entire occiput is evenly rounded and without a transverse carina. The head is yellow, except for the black occiput; thorax black with yellow margins; basal half of lateral elytral margins yellow; second protarsal joint clearly lobed."

A review of the description of all the European genera of Malachiidae, as given by Abeille de Perrin (1891) fails to disclose any which possesses the peculiar tarsal modification shown by this species. The pronounced excavation of the head strongly resembles that seen in various species of *Hedybius* Erichson, a South African genus, but the male protarsi in this genus, according to Champion (1921), are either simple or have the second segment lobed, as in *Attalus.* It is further unlikely that a single representative of a genus confined to South Africa would occur in the United States. *Carphurus* Erichson and its derivative genera, one species of which is reported later in this paper as occurring in Lower California, also have the male first protarsal segment modified, but the modification is very different from that occurring in *Nodopus,* consisting of a heavy black comb along the inner edge of the segment, which is frequently elongated.

Attalus Erichson

The only key which has been published for the North American species of this genus is that of Horn (1872). He included 22 species in his key, omitting *A. rufomarginatus* (Motschulsky). In 1894, Horn described two new species from Lower California; in 1879, Fall described one species from the islands off the coast of southern California; in 1910, Blatchley described two varieties from Indiana and in 1914 one new species from Florida. In

1912, Fall described 12 new species and gave a key by which they might be separated among themselves. In 1920, Leng listed 39 species and two varieties in his catalogue, including *A. subfasciatus* Gorham, a Mexican species, from Arizona, on whose authority I do not know. Since that time five new species and one subspecies have been described, one by Blatchley (1922), one by Hopping (1937), one by Marshall (1946), and three by the same author (1949). With the 11 new species to be described herewith, it becomes necessary to include 57 species or forms in the present key, *A. paralellus* Horn having been reduced to synonymy with *A. rufiventris* Horn by Fall (1917), and *A. nigrellus* Leconte having been transferred back to the genus *Acletus* by the present author (1949). In 1914, Champion listed 52 species of *Attalus* from Mexico and Central America. Two of these belong to the genus *Tanaops,* and two others are known to occur in the United States. This gives a total of 105 species of *Attalus* described from the North American continent to date, not taking into account any which may have been described by other European authors since 1914 and of which I have no knowledge. The probability is that many more species remain to be described from Mexico and Central America before our knowledge of the genus is complete, and it is my intention to enter this field in the next number of these studies, beginning with a collection of Malachiidae from Mexico, made by an expedition from the American Museum of Natural History in the summer of 1947, which Dr. Mont A. Cazier has kindly agreed to turn over to me for study.

Both Horn and Champion based their keys to the genus largely on differences in color and Fall did the same in the short key which he gave for his 12 new species in 1917. The color is quite variable in many of the species but, on the other hand, structural peculiarities are scarce in the genus, and most of the few used by Champion do not occur in any of our species. Good characters are found in several species in the modifications of the abdominal segments in the male and in the size and shape of the pygidium and terminal sternite in both sexes, most of which have not previously been recorded. I have taken advantage of these where they occur and have to some extent obviated the disadvantage of color variability by placing certain variable species in more than one portion of the key.

The relative length and width of the head was the character used by Horn to separate a small group of long-headed species which superficially resemble *Tanaops.* His primary distinction was between "Head elongate, longer than wide. Front nearly flat" and "Head broad, front convex." He included one, however, in the broad-headed species which my measurement shows to have the length 1.06 times the width and three which have the length and width exactly the same. In order to determine whether this character is still available as a primary distinction with the increased number of species, I measured the length and width of the head in 48 species and found the length-width ratio to vary from 0.76 to 1.38, 29 species having a ratio less than 1.0 (short head) and 14 a ratio greater than 1.0 (long head). In five species the length and width of the head were exactly the same. Eighteen species had the ratio between 0.91 and 0.94 and the entire series showed a rather uniform distribution curve, with no definite separation into two groups. With one exception, the greatest difference between adjacent ratios was 0.04. This exception, a difference of 0.11, occurred between the ratios 1.25 and 1.36 and served to separate only three exceptionally long-headed species. When it is considered that, in all probability, species will be discovered that will fall between these limits and also that the apparent length of the head is affected by the degree of flexion present, exposing more or less of the occiput, as well as by the degree of extension of the elastic membrane between the labrum and the clypeus, it becomes obvious that this character is not suitable as a primary distinction, although it is useful in separating certain species that superficially resemble one another. A further argument against the primary use of this character, if any were needed, is its variability within the limits of a single species. For instance, in 10 specimens of *A. nigripes* Horn, the ratio varied from 0.96 to 1.25. All but four of these specimens would have been erroneously placed, by Horn's key, in the long-headed group.

Key to the North American Species of Attalus, North of Mexico

1\. Elytra entirely black or piceous.......... 2
Elytra not entirely black or piceous.......... 21

2\. Head and thorax rufotestaceous.......... 3
Head and thorax at least in part dark.......... 4

3\. Abdomen pale rufous .... *A. melanopterus* (Erichson)
Abdomen black .... *A. atripennis* Fall

4\. Thorax entirely black or piceous.......... 5
Thorax not entirely black or piceous.......... 14

5\. Upper surface nearly glabrous.......... *A. glabrellus* Fall
Upper surface distinctly pubescent.......... 6

6\. Male with ventral foveae; last tergite notched at tip.......... *A. rusticus* Fall
Male without ventral foveae 7

7\. Form broadly oval; length 1.8 mm. or less.......... 8
Form oblong, only slightly dilated posteriorly; length 2.0 mm. or more.......... 9

8\. Legs all pale testaceous; elytra minutely granulate.......... *A. granularis* (Erichson)
Femora black; elytra not granulate.......... *A. australis* Blatchley

9\. Color uniform piceous, bronzed, shining; legs in part pale; 2 mm.; Lower Calif. .... *A. unicolor* Horn
Color black, not at all bronzed; larger than 2.0 mm.......... 10

10. Elytra sooty and faintly iridescent; last tergite of male squarely truncate ..... *A. pallifrons* (Motschulsky)

Elytra not sooty or iridescent; last tergite of male not truncate 11

11. Female with a deep notch at apex of last sternite, which is convex; male with last tergite parabolic, with a small semicircular notch at apex 12

Female with last sternite concave and unmodified at apex; male with last tergite triangular and widely emarginate at apex ..... *A. greeni* Marshall

12. Apical notch in female deep, more than one-half length of segment, which is more convex, less shining, more densely and coarsely pubescent ..... *A. frosti*, new species

Apical notch in female smaller, less than one-half length of segment, which is less convex, more shining, more sparsely and finely pubescent 13

13. All the legs testaceous in both sexes, except the hind femora, which are mostly piceous ..... *A. morulus smithi* Hopping

All the legs piceous, the anterior pair in the males usually pale ..... *A. morulus* (Leconte)

14. Males with ventral foveae 15

Males without ventral foveae 16

15. Males with a white scale-like structure projecting from the posterior margin of the fourth sternite; last tergite not notched at the tip ..... *A. illinoisensis*, new species

Males without such a structure; last tergite notched at the tip ..... *A. foveiventris* Fall

16. Head entirely black (clypeolabral membrane excepted) 17

Head not entirely black 20

17. Abdomen black in both sexes; thorax with basal margin narrowly pale; elytra markedly dilated posteriorly ..... *A. lecontei* Champion

Abdomen not entirely black in both sexes, black in female, more or less pale in male; thorax variable; elytra only moderately dilated posteriorly 18

18. Surface densely pubescent; males with a ventral scale, as in *A. illinoisensis* ..... *A. grisellus* Fall

Surface moderately or sparsely pubescent, males without ventral scale 19

19. Smaller, 1.6–2.0 mm.; pubescence moderate; thorax black with posterior angles pale ..... *A. futilis* Fall

Larger, 2.0–2.5 mm.; pubescence sparse; thorax rufous, with variable dark discal area ..... *A. nigripes* Horn

20. Larger, 2.5–3.0 mm.; elytra sooty black; thorax pale, with median black stripe; pygidium truncate ..... *A. otiosus* (Say)

Smaller, 2.0–2.5 mm.; elytra shining piceous-black; thorax black with yellow margin of variable extent (at times entirely black); tip of pygidium rounded and notched at apex ..... *A. scincetus confusus* Blatchley

21. Elytra black or piceous, with tip narrowly pale 22

Elytra colored otherwise 26

22\. Head in part or wholly pale 23

Head black 25

23\. Elytra and abdomen piceous; head yellow anterior to middle of eyes .... *A. scincetus confusus* Blatchley

Elytra black, abdomen rufous 24

24\. Elytra greenish black; head rufous with black spot of variable size each side of occiput .... *A. semirubidus* Fall

Elytra black or bluish black; head entirely pale .... *A. marginipennis* Blatchley

25\. Elytra black; pale color confined to exact tips (extending narrowly up lateral margin for short distance in most males) .... *A. terminalis* (Erichson)

Elytra piceous; pale color extending up suture for a short distance, but not touching it .... *A. varians* Horn

26\. Head and thorax concolored, pale 27

Head and/or thorax at least in part black 36

27\. Antennae unusually heavy and strongly serrate; elytra rufous with apical and basal spots; terminal segments (both dorsal and ventral) unusually large .... *A. serraticornis* Fall

Antennae feebly or only moderately serrate 28

28\. Elytra pale with black humeral spot .... *A. humeralis* Leconte

Elytra otherwise colored 29

29\. Elytra pale with apical and basal spots 30

Elytra otherwise colored 32

30\. Tarsi and tibiae black; elytra dull .... *A. rufiventris* Horn

Tarsi and tibiae pale 31

31\. Upper surface shining; Eastern .... *A. pettiti* Horn

Upper surface alutaceous; Lower California .... *A. balteatus*, new species

32\. Elytra black, dull, with suture and apices rufous .... *A. rufiventris* Horn

Elytra otherwise colored 33

33\. Elytra with scutellar pale area and elongate piceous spot from humerus to apex .... *A. tucsonensis*, new species

Elytra entirely pale or with an ill-defined subapical spot 34

34\. Male with ventral scale; surface dull, densely pubescent .... *A. oregonensis rubyae*, new variety

Male without ventral scale, surface shining, sparsely pubescent 35

35\. Larger, 4.0 mm.; elytra long .... *A. tucsonensis sanctus*, new subspecies

Smaller, 1.8 mm.; elytra short .... *A. sulphureus*, new species

36\. Antennae unusually heavy and strongly serrate; elytra rufous with apical and basal spots .... *A. serraticornis* Fall

Antennae feebly or only moderately serrate 37

37\. Head with an elongate frontal tubercle........*A. tuberculifrons* Fall
Head not tuberculate........38

38\. Elytra black, with antemedian pale fascia........39
Elytra not fasciate........40

39\. Thorax strongly narrowed behind........*A. transmarinus* Fall
Thorax rounded at the sides, not narrowed behind........*A. subfasciatus* Gorham

40\. Elytra with apical half black, basal half yellow........*A. dimidiatus* Fall
Elytra otherwise colored........41

41\. Male with a white, scale-like structure, projecting from the posterior margin of the fourth abdominal segment; elytra pale with black median vitta on each........*A. oregonensis* Horn
Male without ventral scale........42

42\. Elytra pale except for piceous scutellar area and with scattered erect, black setae........*A. setosus* Horn
Elytra otherwise colored........43

43\. Head black (clypeolabral membrane excepted)........44
Head at least in part pale........48

44\. Head long, one-half longer than wide........*A. rostratus* Horn
Head short, not longer than wide........45

45\. Sutural margin of elytra black........*A. diffusus*, new species
Sutural margin of elytra pale........46

46\. Larger, 2.0–3.5 mm.; thorax pale with broad median black stripe; elytra black with all margins (except the basal) narrowly and uniformly yellow........*A. circumscriptus* (Say)
Smaller, not over 2.0 mm.; thorax black with basal and lateral margins narrowly pale (at times anterior margin also pale and black discal area trilobed in *A. lobulatus)*........47

47\. Sutural margin broad, strongly dilated anteriorly, not reaching the scutellum........*A. lobulatus* (Leconte)
Sutural margin narrow, uniform, not dilated, usually reaching the scutellum........*A. utahensis*, new species

48\. All elytral margins, including basal, pale........*A. cinctus* (Leconte)
Basal elytral margins not pale........49

49\. Elytra pale yellow with sutural and, at times, lateral margins piceous........*A. scincetus* (Say)
Elytra otherwise colored........50

50\. Elytra piceous, with apex, juxtasutural stripe and lateral marginal spot whitish........*A. zebraicus* Blatchley
Elytra otherwise colored........51

51\. Elytral tips black, lateral and sutural margins narrowly and indefinitely paler........*A. dilutimargo* Fall
Elytral tips pale........52

52\. Elytra pale with common basal spot and subapical spot in each, black ...... *A. trimaculatus* (Motschulsky)

Elytra otherwise colored 53

53\. Male with ventral pits; elytra with a broad black vitta on each, narrowed near the middle ...... *A. subtropicus*, new species

Male without ventral pits 54

54\. Abdomen rufous 55

Abdomen black, except the membranous portions 56

55\. Head short, length-width ratio 0.76; elytra dull black, margins pale ...... *A. rufiventris* Horn

Head long, length-width ratio 1.17; elytra shining, aeneous black, margins pale ...... *A. santarosae*, new species

56\. Pale color of head confined to clypeus; thorax mostly black; elytra vittate ...... *A. demissus* Fall

Pale color of head not confined to clypeus 57

57\. Black disc of thorax lobulate, in three parallel, more or less confluent, spots or stripes, the central longest ...... *A. lobulatus* (Leconte)

Black disc of thorax, if present, not lobulate 58

58\. Elytral margins narrow, not dilated ...... *A. circumscriptus* (Say)

Sutural or lateral margin, or both, dilated 59

59\. Larger, 3.5 mm 60

Smaller, 2.0–2.5 mm 61

60\. Thorax pale, with central black stripe or spot; only the second antennal segment pale; only the anterior tibiae pale ...... *A. rufumarginatus* (Motschulsky)

Thorax black, with narrow basal and lateral margins pale; first two antennal segments or more pale; first two pairs of legs more or less pale, especially the femora ...... *A. difficilis* (Leconte)

61\. Sutural pale margins strongly dilated and depressed and usually not continuous with pale apical margins; elytra thin, shining ...... *A. texanus* Marshall

Sutural pale margins narrowly dilated and broadly continuous with apical margins; elytra normally thick and dull ...... *A. minutus* Marshall

Of the 57 species and varieties included in the above key, 51 are before me. Of the remaining six, I have examined the types of three, *A. tuberculifrons*, *A. transmarinus*, and *A. dilutimargo*. In the case of the other three, *A. marginipennis*, *A. subfasciatus*, and *A. rostratus*, I have taken the characters made use of in the key from the original descriptions. No one could be more aware of the imperfections in the key than the author himself. Like most keys, it should be used merely as a guide and not to the exclusion of the original descriptions and of any other information that is available concerning the species in question. Such observations concerning the individual species as I think are worthy of recording will follow, the species being considered in the order in which they appear in the key. Incidentally, this order is merely one of convenience and is not intended to represent any opinion concerning the phylogenetic relationships of the species.

Attalus melanopterus (Erichson)

The only specimen of this species which was known to Horn (1872) had the "legs pale rufous, hind femora at the tip piceous." Five specimens are before me, all females, of which three have the legs colored as in Horn's specimen. One, from Ohio, has the legs all rufous and one, from Florida, has the legs all black, except the proximal ends of the anterior femora.

Attalus glabrellus Fall

Fall states, in his original description of this species: "Black, thorax typically with a rufous spot at the hind angles, varying to entirely black, or with the sides broadly rufous." In a series of 60 specimens, from various points in Southern California, Arizona (Santa Rita and Chiricahua mountains), and Texas (Davis and Chisos mountains), the thorax is entirely rufous in the majority of specimens. In some, there is a central black spot, usually placed near the anterior margin; others are colored as were Fall's specimens, but only three specimens out of the lot have the thorax entirely black. The legs are correspondingly paler than described by Fall. *Attalus lecontei* Champion, to which Fall compares *A. glabrellus*, appears to be much rarer and, in addition to the differences noted by Fall, is more elongate and has the elytra distinctly pubescent.

Attalus morulus Leconte

The type series of *A. morulus* was recently discussed by me, in the second number of these studies (1949). A subsequent personal examination of the holotype, at the Museum of Comparative Zoology, showed it to be identical with the form which I described in the same paper, under the name *A. smithi coloradensis*. According to the notes which I made at the Museum of Comparative Zoology, "the clypeus and labrum are piceous, genae and mandibles yellow, first two pairs of legs testaceous, hind femora piceous, the tibiae and tarsi piceotestaceous. The last sternite shows all the characters set forth in my key (1949) for *A. s. coloradensis*, with the notch slightly less than one-third the length of the segment." At the time Mr. Frost and Dr. Darlington made the comparison referred to (Marshall, 1949), they did not have examples of *A. s. coloradensis* at hand, as that had not yet been recognized as distinct from the form referred to as "Morulus I" in that paper.

Attalus s. coloradensis Marshall thus becomes a synonym of *A. morulus* and *A. smithi* Hopping a subspecies of *A. morulus*. *Attalus greeni* Marshall, treated in the same group (Marshall, 1949), remains unaffected but the species there treated as *A. morulus* remains without a name and I propose for it the name *Attalus frosti.*

Attalus frosti Marshall, new species

Male. The male was described in the paper referred to above (Marshall, 1949) as the allotype of *A. morulus* and the specimen so labeled becomes the holotype of *A. frosti.*

Female. Slightly more widened posteriorly than the male. Color uniform piceous-black, except for the abdominal segments, which are piceous and the anterior edge of the clypeus, the labrum, mandibles, under surface of first three antennal segments, and anterior tibiae and tarsi, which are piceotestaceous. Pubescence and sculpturing as in the male. Antennae shorter, scarcely serrate, extending only two segments beyond the thoracic base. The pygidium has a small apical notch, as in the male. The last sternite is quite convex, moderately shining, rather densely, and finely punctured and covered with numerous long black hairs; the notch is about two-thirds the length of the segment and is narrowed caudally.

Length 2.8 mm. to tips of elytra.

Holotype, male, "**Linwood, New Jersey** VII–17–44" and allotype, female, "Mt. Pocono, Pennsylvania, VII–9–29", both collected by Mr. J. W. Green, are in the author's collection. Paratypes also in the collections of Mr. Green and Mr. Frost. Named in honor of Mr. C. A. Frost, in appreciation of his assistance in working out the relations of the group and of the many other favors he has shown me. The variation in the type series, which is very slight, is discussed in the paper already referred to.

The relations of the group may be summarized as follows:

Attalus morulus Leconte *(A. coloradensis* Marshall)
  subspecies *smithi* Hopping
Attalus frosti Marshall
Attalus greeni Marshall

Attalus illinoisensis Marshall, new species

Male. Elongate oval, the elytra strongly widened posteriorly. Black, under surface of first two antennal segments and a small spot at each posterior thoracic angle piceotestaceous; tibiae, tarsi, and abdominal segments piceous, the margins of the latter paler. *Head* short, triangular, inserted in the thorax to the eyes, length-width ratio 0.91, front with a shallow, but broad semicircular depression, the surface marked with fine cracks, which radiate upward and outward from the center of this depression. *Antennae* slender, scarcely serrate, passing the posterior thoracic margin by three segments. *Prothorax* quadrate, 1.3 times wider than long, the sides slightly converging posteriorly, the angles all broadly rounded, the anterior margin slightly produced; surface shining, punctuation and pubescence very fine and inconspicuous. *Elytra* only moderately shining, suture depressed, punctuation and pale pubescence as on the thorax, a few erect black setae near the lateral and apical margins. Pygidium small, triangular, and narrowly truncate at the tip. *Under surface* and legs with punctuation and pubescence rather dense but fine and inconspicuous. The fourth abdominal segment has a transverse, thickened ridge which overhangs the retracted median portion of the posterior border and from the center of this border a small, pale, scale-like structure, as in *A. oregonensis,* projects down over the fifth segment, which has a pair of ventral pits near its posterior border. Lobes of second protarsal segments smaller than usual, narrow, reaching only about the middle of the third segment, the tips rounded and very narrowly edged with black.

Female. Similar to the male, except as follows. Antennae shorter, very slender and not at all serrate. Thorax with broad pale lateral margins, which narrowly join across the basal margin; pale margins of abdominal segments wider; last sternite broadly depressed in the center.

Length, male 2.0 mm., female 2.6 mm.

Holotype, male; and allotype, female, labeled "**S. Ill.** June. Bock. A. Fenyes collection," in collection of California Academy of Sciences.

Two male paratypes, same data, in author's collection. The paratypes both have the posterior thoracic angles broadly pale and the last two sternites entirely pale. No other noteworthy variations are present.

This species is the only one known to me in the genus which has both ventral pits and the ventral scale. It resembles certain specimens of both *A. pallifrons* and *A. otiosus,* but may be known from both of these species, in addition to the character just mentioned, by its smaller size, more widely dilated and more shining elytra and the absence of yellow markings on the front of the head and anterior two pairs of legs. The color of the thorax is obviously variable and unreliable.

Attalus lecontei Champion

Horn, in his 1872 key, states that this species has the "thorax with pale *apical* margin, apex of elytra bordered with testaceous," whereas in his discussion of the species he states that the *base* of the thorax is margined with yellow and that in the *male* the apex (of the elytra) and a small portion of the sides and suture are bordered with yellow. In the original description Leconte states that the thorax has the *base* flavo-emarginate. I have examined Leconte's unique female type, which agrees with the original description. The statement in Horn's key is clearly an error.

Horn was also in error in stating that the yellow markings at and near the elytral apices are a sexual character. I have males with all black elytra and females with the yellow markings, as well as specimens in which the opposite state of affairs prevails. It seems that the yellow markings are more prominent in certain localities; for instance, in a series of 16 specimens from Mecca, California, all but two of them show the yellow markings more or less well developed. The yellow or orange color typically forms an elongated triangular area, with the base at the elytral apices and the apex of the triangle at about the posterior third of the suture. In several of the specimens the yellow thoracic basal margin, which is usually white rather than yellow, includes the posterior angles and in a few extends up the sides to form broad yellow lateral margins. This species can be very troublesome in its identification, as shown by one well known collection in which the series labeled *A. lecontei* contains three specimens, one *A. futilis,* one *A. glabrellus,* and one *A. lobulatus.* The specimens with all black elytra can be easily confused with specimens of *A. futilis* or *A. glabrellus* that have the thorax with a yellow basal margin, as is not infrequently the case; but hardly with *A. lobulatus. Attalus glabrellus* and *A. futilis* are both larger species and are not so definitely dilated posteriorly as *A. lecontei,* although Horn definitely exaggerates when he states that *A. lecontei* (=*basalis)* is almost as broadly dilated as *A. granularis. Attalus futilis* is much more densely pubescent and *A. glabrellus* is more glabrous and more finely pubescent and the legs in both these species, when they become pale in part, do not have the banded appearance of the legs in *A. lecontei.* The females of *A. lecontei* can be easily separated from the other two species by the fact that the last sternite, which is long and triangular in shape, has a small acute notch at the rounded apex.

Attalus grisellus Fall

A series of 135 specimens, from the Badlands of South Dakota, is referred to this species and shows practically no variation, except in the color of the prothorax, which varies from all yellow to black with the posterior angles broadly yellow, the latter being the color in the type series of nine specimens. I have the same species, previously recorded only from the type locality in New Mexico, also from western and central Texas. Fall states that this is possibly ''no more than a variety or race'' of *A. futilis.* I have compared specimens of this species, as well as those of *A. futilis,* from Arizona, with Fall's types of *A. futilis* and his paratypes of *A. grisellus* (the type of *A. grisellus* is in the collection of the Philadelphia Academy of Sciences), but owing to lack of time, I made no close study of the abdominal segments. If my identification of these two species is correct, these structures show clearly that they are distinct species. In *A. grisellus,* the fourth segment has an oblique, hairy carina or ridge on each side, in the male, with a whitish scale-like structure projecting from the middle of the posterior edge down over the fifth segment, much as in *A. oregonensis.* In some specimens these ridges are almost obsolete, while in others they form overhanging, posteriorly projecting lobes; the centrally placed scale-like structure appears to be constant. The pygidium is unusually small for the genus, and is almost triangular, with the tip narrowly rounded. In *A. futilis* there is no modification of the fourth segment, but the fifth segment has the posterior margin membranous, yellow, and broadly emarginate. The head in *A. grisellus* is also definitely longer than in *A. futilis.* Further opportunity to examine the types may show that we are dealing with a new species. Unfortunately, Fall makes no mention of the secondary sexual characters in his description of either *A. grisellus* or *A. futilis.*

A series of 134 specimens in the collection of Mr. J. W. Green, mostly from the Jemez Mountains, New Mexico, shows the same variation in the color of the prothorax as does the series from South Dakota, the color being entirely black in some specimens.

Attalus futilis Fall

In addition to the above remarks concerning this species, under *A. grisellus,* it is noted that Fall compares this species with *A. morulus,* from which it is abundantly distinct. It is much more apt to be confused with *A. lecontei,* which is less densely pubescent, more dilated behind and with the head definitely wider. The color differences as to the legs and the base of the thorax are not reliable.

Attalus nigripes Horn

In his original description of this species, Horn (1870) states: ''body beneath and legs black'' and in his 1872 key he repeats: ''legs entirely black.'' These statements are correct so far as concerns the females, but most of the males have the anterior two pairs of legs yellow, except for the tarsi and knees, and the last three abdominal segments yellow in part. The males show a modification of the fourth and fifth sternites which is quite distinctive and which has not been previously noted, to my knowledge. The central third of the fourth segment is black and ends posteriorly in a roughened, elevated ridge that slightly overhangs the true posterior border of the segment. The remainder of the sternite is yellow, except for the anterior angles. The fifth segment presents a similar structure, but the ridge here does not reach the posterior edge of the segment, the black central area has a median carina and both ridge and posterior border of the segment have an acute median emargination. The terminal segment, both sternite and tergite, is larger and thicker than usual in the genus and the sternite is made up of two lateral, mandibuliform lobes, with concave median edges, leaving an unusually large genital aperture. The fifth and sixth sternites, with the exception of the black median lobe of the fifth, are entirely yellow.

Attalus semirubidus Fall

This species was described by Fall in 1917 from a unique male and, so far as I know, has not been mentioned since in the literature, except for its listing in Leng's catalogue. The type was from Mobile, Alabama. A series of 29 specimens, from various points in Mississippi: Lucedale, Leaf, Leakesville, Beaumont, North Augusta, and Green County, all collected by Dr. Henry Dietrich, enable me to record the extent of variation shown by the species.

Several of the males agree in every particular with Fall's description. They vary from 2.0 to 2.5 mm. in size. The females vary from 2.5 to 2.8 mm. About half the females have the abdominal segments spotted with black and, in one specimen, these segments are entirely black, with the posterior borders rufous. The following variations in color appear to be unrelated to sex. In most cases, the elytra are shining black, with a faint purplish tinge and the line of demarcation between the black elytral discs and the rufous apices is sharply defined; in a few the discs become piceous or rufopiceous in color, with a very poorly defined distinction between the discs and the apices. The rufous color of the apex may or may not extend around the lateral margins for a variable distance; in some cases the entire lateral margins are rufous. The pale color does not extend up the suture in any case. The head in several specimens is entirely rufous, with only a suspicion of a dark spot just inside the upper end of each eye. These spots become larger and blacker in most specimens and eventually coalesce to give a completely black occiput, as in the type. In a few specimens the black color then extends down onto the front for a variable distance and, in one female, the head is entirely black, with a yellow trilobed frontal area just above the clypeus. The legs are mostly as in the type, the femora rufous and the tibiae and tarsi dusky. In some specimens the distal ends of the posterior two pairs of femora are black and in a few the posterior pair of legs is entirely black.

Attalus terminalis (Erichson)

Horn (1872) states that the tips of the male elytra and a narrow space along their sides, not attaining the humeri, are bordered with yellow. He makes no mention of the females, but neither does he state that all of his specimens were males. Blatchley (1910) makes the definite statement, which is an error, that the females are uniformly black above. Examination of a series of about 200 specimens, the majority of which are females, from New York, New Jersey, Maine, Massachusetts, Ontario, Maryland, Minnesota, Iowa, Pennsylvania, and Tennessee shows the following: most of the males have the elytra colored as Horn states, but in some the narrow lateral bead is yellow as far as the humerus and in these cases all the legs are apt to be testaceous; most of the females have the elytral tips more narrowly yellow than the males and the pale color does not invade the lateral margin. Some females, however, have the elytra colored as in the average male and some males as in the average female. In only two females of the lot are the elytra uniformly black. In quite a few specimens the elytra are piceous, rather than black.

Attalus serraticornis Fall

One male, from Imperial County, California, which I refer to this species, does not have the metasternum or ventral segments black, as in the type and the antennal segments three to six are not quite as wide as long. It does have the last ventral segment more strongly produced and impressed, as described by Fall, than any other species with which I am familiar.

Attalus humeralis Leconte

This rare, but easily recognized, species was evidently known to both Leconte and Horn only from the unique type specimen, from Peoria, Illinois, and, to my knowledge, has not been mentioned in the American literature since. I have seen it in several collections, mostly uniques, including my own and all of the specimens, about half a dozen, have been from Brownsville, Texas. I am inclined to believe that the locality label on Leconte's type was an error.

Attalus rufiventris Horn

This species varies in its coloring to a greater extent than has been indicated by previous authors, so much so that the delimitation of the species and its satisfactory placement in any key become difficult matters. Even after we agree that Fall (1917) was correct in placing *A. paralellus* Horn as a synonym of *A. rufiventris,* the variation described by Horn (1872), in which the "occiput and narrow median thoracic stripe (are) black," by no means exhausts the possibilities. In a series of 90 specimens, from various points in Texas, southern New Mexico, southern Arizona, and southern California, only seven are typical *A. rufiventris,* with the thorax and head entirely red and these are all females. Of all the others which have the elytra typically colored, with only a narrow sutural margin and the apices red, 21 in number, represent Horn's "variety," noted above and are all males except one, showing that this variation is mainly sexual in character. In some the thoracic stripe is abbreviated, forming a median anterior thoracic spot. In many the black color of the occiput extends for a variable distance down the front, in some reaching the clypeal suture. In most of those which have the lower portion of the front yellow, the pale color forms a transverse band above the clypeus, but in a few it forms a definitely trilobed frontal area, as in several other species. Ten of the specimens, from southern Texas and southern California, have the elytra quadrimaculate and are Horn's *A. paralellus.* The remaining specimens, which constitute the majority of the entire series, show all degrees of intermediate stages between the elytral coloring of the typical specimens and the quadrimaculate form. Some show an elytral pattern resembling *A. trimaculatus,* but these may be distinguished from *A. trimaculatus,* in addition to the short head, by the fact that the apical spots always attain the lateral elytral margins. In the southern Arizona specimens, twelve in number, from Tucson and Wickenburg, the basal portion of the pale sutural margin tends to become widely dilated, forming a red triangle whose sides extend from the elytral humeri to a point near the apex of the suture. In the extreme forms of this variation, the scutellum is also entirely pale. In a series of ten from southwestern New Mexico (Hidalgo County), the abdomen is more or less heavily maculate with black, in the majority being entirely black, with the borders of the segments pale, thus belying the specific name. A series of nineteen specimens from the Santa Rosa Mountains, in southern California, appear to be typical *A. rufiventris,* except for a strong tendency to the quadrimaculate form, eight of the ten of such forms mentioned above occurring in this series. The scutellum in all of these specimens, however, remains black, whereas in typical *A. paralellus,* from southern Texas, it is testaceous. Specimens of the quadrimaculate form, from Prescott, Arizona, received after the above notes were made and which are associated with typical *A. rufiventris,* have two black dots on the prothorax, of variable size, arranged as in *Collops bipunctatus.*

It is possible that I have included more than one species in this lot of material and, in fact, I have separated two forms from the original confused lot, presently to be described as new, largely on the basis of characteristic modifications of the genital segments. With these exceptions, however, intermediate examples appear to be present to connect all the extremes noted. It seems that this species is in a state of active evolutionary change at the present time and is splitting up into several derivative forms, which are not as yet sufficiently isolated or distinct to be defined as sub-species. I believe that we can best obtain a concept of such species by carefully noting the extent and the locale of the variations in such series as it has been my privilege to examine.

Attalus pettiti Horn

One specimen, a male, from Clear Lake, Wisconsin, has the apical black spot wanting, giving it a considerable resemblance to *A. humeralis.* The latter, however, is more dilated posteriorly in the same sex, more ovoid in shape, with the elytra transversely impressed at the anterior third, more coarsely punctured and more densely pubescent. The metasternum in *A. humeralis* is pale, in *A. pettiti* black; the pygidium in *A. humeralis* is entire, in *A. pettiti* strongly notched at the apex.

Attalus balteatus Marshall, new species

Male. Oblong, parallel, the elytra not widened posteriorly. Rufotestaceous; the scutellum, a pair of spots on each elytron, the metasternum, a pair of spots on each sternite, and the exposed tergites piceous. Upper surface strongly alutaceous, the elytra slightly less so than the head and thorax. *Head* short, oval, one-tenth wider than long, eyes small, tempora somewhat produced, front unimpressed, punctuation and pubescence extremely fine and sparse. *Antennae* short, extending beyond the posterior thoracic margin by not more than one segment, scarcely serrate, moderately pubescent. *Prothorax* transverse quadrate, 1.3 times wider than long, the sides slightly converging posteriorly, the apical margin slightly produced. Punctuation and pubescence as on the head. *Elytra* slightly lighter in color than cephalothorax, the piceous spots with a faint violaceous tinge, the basal spots extending entirely across the base and along the suture, but not involving the latter, the subapical spots larger, broadly involving the lateral margins, their inner edges tangential to the suture, the elytra apices pale. The elytra might with almost equal propriety be described as piceous, with a subbasal fascia and the apices pale. Punctuation fine and sparse, pubescence very fine and inconspicuous, the fairly numerous erect, black setae also observable only in a favorable light. Three tergites exposed beyond the elytra; the pygidium moderate in size, semicircular and evenly rounded. *Under surface* very finely punctured and pubescent, the abdominal segments with no distinctive modifications. Lobes of the second protarsal segments rather prominent, convex in cross section, dilated toward the ends and almost reaching the ends of the third segments, the tips narrowly black.

Female. Similar to the male, except as follows. Antennae shorter, about reaching the posterior thoracic margin, not perceptibly serrate; ventral segments entirely piceous, the last with the midline deeply impressed; elytra no more widened behind than in the male, three tergites exposed, pygidium truncate at the tip.

Length, male and female, 1.8 mm. to tips of elytra.

Holotype, male and allotype, female, labeled "**San Francisquito Bay, Gulf of Calif.** June 23, 1921. E. P. Van Duzee, collector." Holotype and allotype in the collection of the California Academy of Sciences.

Seven paratypes, one male and six females, six with the same data as the types, one "8 mi. N.E. Cape San Lucas, L. Cal. VII–10–38." Paratypes in the author's collection and in that of the California Academy of Sciences.

The paratypes are mostly lighter colored than the types, some of them at least from immaturity. In the male paratype, the basal elytral spots are reduced to two piceous streaks adjacent to the basal end of the suture and in some of the females these spots are practically absent. The female from Cape San Lucas is darker than the types, the parts described as rufotestaceous in the types (except the elytra) being piceotestaceous.

The species does not appear to have any close relatives in our fauna. If it is regarded as fasciate, instead of spotted, which it might well be, it runs to *A. debilicornis* Champion in Champion's key (1914), which he described from a single male, from Guatemala. This species, however, has the upper surface shining and the elytra "much widened posteriorly," which characters separate it at once from *A. balteatus.*

Attalus tucsonensis Marshall, new species

Male. Oblong, slightly and gradually widened posteriorly. Color rufotestaceous, an elongate spot on each elytron, the terminal seven antennal segments, the middle and posterior tarsi, tibiae and distal ends of femora, tip of the last sternite and tip of pygidium piceous. *Head* short, length-width ratio 0.92, front evenly convex, apparently impunctate, pubescence pale and so fine as to be visible only in an oblique view, a few erect black setae across the occiput. *Antennae* moderately serrate and pubescent, extending beyond the thoracic base by about three segments. *Prothorax* transversely oval, one-fourth wider than long, all the angles broadly rounded, surface and pubescence as on the head, the erect black setae concentrated near the anterior margin and the midline, inclined cephalad, an erect fringe of setae at the posterior angles. *Elytra* with an elongate piceous spot on each, drumstick-shaped, commencing at the humeral umbo and expanding in the posterior half, almost reaching the lateral margin, but distant from both the sutural and apical margins; the surface moderately shining, the punctuation and pale pubescence dense and extremely fine, the erect black setae uniformly scattered over the entire surface. *Under surface* very finely punctured and pubescent, the legs more distinctly so, a few erect black hairs on sternites three, four and five, more numerous on sternite six and the last two tergites. Pygidium quadrate, the sides converging posteriorly and slightly sinuate, the tip rounded-truncate. The last sternite consists of a pair of triangular lobes, extending about one-half the way to the end of the pygidium, the median edges concave, the tip terminating in a sharp hook, projecting mediad, resulting in a large oval opening, through which can be seen practically all of the ventral surface of the pygidium and the adeagus. The lobes of the second protarsal segments are large, spatulate, the tips rounded and with a heavy black edge around the tip and about the terminal half of the median edge.

Female. Similar to the male, except that the antennae are shorter and feebly serrate; the pygidium is of the same size and shape as that of the male, but there is a deep, parallel-sided notch, occupying about one-third the width of the pygidial tip and extending from the tip about one-third the distance to the base of the segment. The terminal sternite is as long as the pygidium and unmodified.

Length, male 3.7 mm., female 3.5 mm.

Holotype, male, "**Tucson, Ariz.** VIII–16–40, D. J. and J. N. Knull, collrs." and allotype, female, "Tucson, Ariz. VIII–13–36, J. N. Knull, collector," are the property of Ohio State University and will be returned to Dr. Knull at that institution.

Fifteen paratypes, five male and ten female, from the following localities: ARIZONA: 2 Sabino Canyon, 2 Globe, 1 Canyon Lake, 1 Wickenburg, 1 Yuma. CALIFORNIA: 1 Palo Verde. MEXICO: 1 Guaymas, Sonora; 1 San Bernardo, Sonora; 2 San Carlos Bay, Lower California; 1 Tiburon Island, Gulf of California. Paratypes in the author's collection and in that of the California Academy of Sciences.

The series shows only a moderate amount of variation. In several specimens, of both sexes, epistoma and frontal margin are pale yellow, the margin in one male showing a trilobed posterior border. In some the basal portion of the elongated elytral spots is very faint, a black humeral spot at times remaining. In one female, the elytra are entirely pale, except for a moderate sized subapical spot. In most specimens the anterior legs are darker than in the types, being colored as are the posterior two pairs. Three males, from Wickenburg and Yuma, Arizona, and from Palo Verde, California, are smaller than the types, about 2.5 mm. and have the pygidium larger. These may represent a distinct species, but in the absence of corresponding females, which in this species display the most distinctive characteristic in the deep pygidial notch, they are provisionally assigned here.

The species would only be confused with the variant of *A. rufiventris* mentioned under the discussion of that species as occurring in southern Arizona. *Attalus rufiventris* is smaller than the types of *A. tucsonensis,* averaging about 3.0 mm., the last sternite of the male completely covers the ventral surface of the pygidium and is merely thickened in the areas represented by the lateral lobes in *A. tucsonensis;* the pygidium of the female is squarely truncate, as in the male, with no notch at the tip. After setting aside the pair of *A. tucsonensis* to be described as new, I was interested to observe that Professor Fall had set aside an identical pair in his collection, at the Museum of Comparative Zoology, obviously for the same purpose.

Attalus tucsonensis sanctus Marshall, new subspecies

Male. Size, shape, sculpturation, and pubescence as in *A. tucsonensis.* Upper surface entirely rufotestaceous; antennae, except under surface of first three segments, tibiae, tarsi, and distal ends of femora piceous. The tooth at the base of the adeagus is large, laterally compressed, the posterior edge vertical, the anterior edge oblique. Other characters as in *A. tucsonensis.*

Female. Similar to the male except for the secondary sexual characters. The pygidium is narrower than in typical *A. tucsonensis* and the pygidial notch, which is the most obvious distinguishing character of the species, is much deeper, extending about three-fourths the distance to the base of the segment and is widened in its anterior portion.

Length, male and female 4.0 mm.

Holotype, male and allotype, female, "**Espiritu Santo Island, Gulf of Calif.,** June 9, 1921. E. P. Van Duzee collector." Holotype and allotype in the collection of the California Academy of Sciences.

Nineteen paratypes, six males and thirteen females, fourteen with the same data as the types, three from Concepcion Bay, Lower California, one "10 mi. E. San Ignacio, L. Cal.," one Ceralbo Island, Gulf of California. Paratypes in the author's collection and in that of the California Academy of Sciences.

This form appears to meet the criteria for designating it as a subspecies of *A. tucsonensis,* since neither occurs, so far as known, in the territory of the other subspecies and the specimens from intervening localities show characters intermediate between the two. The male specimen from Ceralbo Island, which is adjacent to Espiritu Santo, is similar to the holotype in every respect, whereas those from Concepcion Bay and San Ignacio, about 200 miles to the north, all show a piceous humeral spot and a similarly colored subapical spot of variable size. The three females from this area also have the pygidial incisure intermediate in depth, occupying about one-half the length of the segment.

Attalus sulphureus Marshall, new species

Male. Elongate-oblong, parallel, the elytra scarcely widened behind. Color pale sulphur yellow, the thoracic disc, most of the head, antennae and legs slightly darker, a pale testaceous, the palpi and middle and posterior tibiae and tarsi piceotestaceous. *Head* short, length-width ratio 0.90, front with a pale, trilobed, ivory-colored border, the middle lobe reaching the middle of the eyes, the lateral lobes reaching the posterior ends of the eyes, surface shining, evenly convex, sparsely and minutely punctulate and pubescent, a few erect black setae on the tempora behind the eyes. *Antennae* very feebly serrate, moderately pubescent, the terminal nine segments missing from the right antenna, the terminal five segments from the left. *Prothorax* transversely oval, 1.25 times wider than long, all the angles rounded, but more definite than usual in the genus, the anterior margin also projecting forward to an unusual extent, the disc marked by three longitudinal, parallel, faintly piceous lines. Punctuation and pubescence inconspicuous, as on the head, a very few erect black setae in the neighborhood of the posterior angles. *Elytra* shining, punctuation and pubescence very minute, sparse and faint, a few black setae along the basal, lateral, and apical margins. Two and one-half tergites are exposed beyond the elytral tips, the same color as the elytra, with more numerous black setae; pygidium small, the sides strongly converging posteriorly, the tip evenly rounded.

Under surface sparsely punctulate and pubescent, the tibiae and tarsi slightly more so; abdominal segments, except the sixth, unmodified; this consists of two rounded lobes, which leave almost one-half the ventral surface of the pygidium exposed. Lobe of second protarsal segment moderate in size, slightly widened distally, the tip rounded and with a black margin.

Female. Similar to the male, except slightly darker; the antennae and all the tibiae and tarsi are piceous; antennae short, barely reaching the thoracic base and scarcely serrate; three and one-half tergites are exposed beyond the elytral tips and the abdomen is strongly narrowed; pygidium elongate, the sides slightly arcuate, the tip rounded-truncate; last sternite convex, unmodified and accurately covering the ventral surface of the pygidium.

Length, to elytral tips, male and female, 1.8 mm.

Described from a series of one male and three females. Holotype, male and allotype, female, "**Ariz.** Ac. 5409. Coll. Chas. Palm." One paratype same data and one labeled "Prescott, Ariz., Ex-Coll. W. T. Davis." It is believed that the Palm collection is now the property of the American Museum of Natural History. If so, the holotype and allotype will be deposited in that museum. The two female paratypes are retained in the author's collection.

One of the paratypes is slightly darker than the allotype and both have four entire tergites exposed. No other noteworthy variations are observed. Four specimens from the Hopping collection, all in very poor condition, are also referred to this species. They show no variation of any consequence.

The species, because of its small size and pale color, might be confused with *A. o. rubyae.* The latter is darker, much more conspicuously pubescent, the head longer and has the characteristic modification of the male abdominal segments mentioned in the key.

Attalus oregonensis Horn

A series of about 200 specimens, from Prescott, Arizona, of which over 80 percent are females, displays a range of variation in this species which has not been previously recorded. The relative length of the head shows considerable variation, the males tending definitely to have shorter heads than the females. Horn describes the head as "black, anterior margin of the front rufous.'' This is the case in many specimens, but the majority have about the anterior one-half of the head rufous, while in some the red color extends up through the central portion of the occiput, leaving only a black spot over each eye and in a very few the head is entirely rufous. As to the thorax, which Horn describes as ''varying in color from rufous with median black space to nearly black with margins and basal angles narrowly rufous,'' about 20 percent have the thorax entirely rufous, while in the majority there is an elongate central black spot of varying size, which at times attains the anterior, but never the posterior, thoracic margin and, in a few specimens, becomes broad enough to occupy the central half of the thoracic width. In another series, from the Santa Rosa Mountains, California, several specimens have the head and thorax entirely black. The abdomen in all the males is ''pale yellowish,'' as stated by Horn, but varies in the females from all yellow, even including the usually black sixth sternite, through a maculate condition to all black. The metasternum, in most specimens black, likewise varies, through various shades of piceous and piceotestaceous, to yellow. The males have a very distinctive modification of the fifth sternite, the posterior border of which is split transversely, to form a shallow depression or pit, the anterior margin of which is obsolete except near the lateral angles and most of the remainder of the segment is occupied by two large, smooth, black depressions, one on each side, which are overhung by the posterior border of the fourth segment. A small, rounded, white, scale-like structure extends caudad from beneath the center of the margin of the fourth segment about as far as the middle of the fifth. This structure, first discovered in *A. oregonensis,* was at first mistaken for a grain of sand, but it proved to be constant in all males and refused to be removed with the point of a fine needle.

Another lot of unnamed *Attalus,* from Lower California, received from the California Academy of Sciences, contains 103 specimens of this species, from 18 different localities, scattered almost throughout the length of the peninsula, both in the interior and along both coasts and including several islands, such as Cedros Island in the Pacific and Tiburon Island, across the Gulf of California, adjacent to the mainland of Sonora. The locality farthest south is Espiritu Santo Island, near LaPaz. This series shows a bewildering amount of variation, rivaling *A. rufiventris* in this respect. In general, those occurring along the West Coast tend to become darker, while those on the East or Gulf Coast are lighter in color than typical *A. oregonensis.* The latter contain specimens of the small, all pale variety presently to be described as *A. oregonensis rubyae,* as well as those in which the only dark markings are a pair of large subapical spots. The scutellum in these may be pale or dark, with or without a pair of black juxtascutellar spots, which in some specimens spread across the elytral base. In others, the scutellum and a pair of humeral spots are black. A series of 19 specimens from Cedros Island are quite uniform in color and are all black, except for narrow elytral margins (excepting the basal), a portion of the genae external to the antennal fossae and the membranous portions of the abdominal segments, which are rufous. Another series of 18 specimens, from Magdalena Bay, are all entirely black, except for the membranous margins of the abdominal segments and have the pubescence unusually dense and silvery. Fortunately, all of these forms contain males, which show the peculiar, characteristic modification of the fourth and fifth sternites. The variation in size is also considerable, from 1.7 to 3.0 mm.

Attalus oregonensis rubyae Marshall, new variety

Male. Elongate-oblong, testaceous throughout, except for palpi and antennae, which are piceous (excepting the three basal antennal segments), the elytra and abdomen slightly paler than the head and thorax, the sterna and legs slightly darker. *Head* slightly elongate, length-width ratio 1.09, feebly impressed between the eyes, the center of the labrum with a piceous spot; surface shining, very finely punctulate and with fine, pale, decumbent pubescence. *Antennae* extending one segment beyond the base of the prothorax, feebly serrate, moderately pubescent. *Prothorax* quadrate, one-fifth wider than long, the sides slightly convergent posteriorly, all the angles broadly rounded, base and posterior angles moderately reflexed, punctuation and pubescence as on the head. *Elytra* not shining, finely and densely punctate, the pubescence fine, pale and decumbent, producing a silky appearance, the erect black setae numerous and uniformly distributed, the pubescence so arranged as to give the impression that the elytra are finely granulate. *Under surface* finely and densely punctulate and pubescent. The fourth segment has an oblique thickened ridge on each side and a white scale-like structure projecting from the midpoint of the posterior margin, as in *A. oregonensis;* the basal portion of the fifth segment is impressed and darker colored on each side of the midline; the sixth segment is divided into two lateral triangular lobes; the pygidium is small, with sides strongly converging and apex evenly rounded and entire. The lobes of the second protarsal segments are slender, slightly dilated and rounded at the tips, the margins narrowly black.

Female. Similar to the male, except as follows. Antennae about the same length and very feebly serrate; each elytron has an ill-defined subapical piceous spot. Head and sternum darker than in the male, piceotestaceous; pygidium slightly longer than in the male; last sternite unmodified.

Length, male 2.2 mm., female 2.3 mm.

Holotype, male and allotype, female, "**Lowell Ranger Station, Pima Co., Ariz.,** July 6–20, 1916," collector unknown, in the author's collection.

Fourteen paratypes, 2 males, 12 females, one with the same data as the types, nine labeled "Inyo Mts., Calif., July 7–11," four "Mtn. Springs, Calif., VIII–23–24." Paratypes in the author's collection and in that of the California Academy of Sciences.

This small, pale form was at first described as a new species, which accounts for the amount of detail in the description, but the receipt of 13 additional specimens, which I have labeled as paratypes, from the California Academy of Sciences, together with their entire collection of *Attalus,* made the retention of the form as a distinct species untenable, since the paratypes showed a definite trend in coloration toward typical *A. oregonensis* and were also intermediate in such other characters as I had used to separate the "species" from *A. oregonensis,* such as the degree of serration of the antennae, the shining surface of the elytra and the density of pubescence.

The peculiar scale-like structure mentioned, on the fourth sternite, is known to me otherwise only in *A. oregonensis, A. illinoisensis* and in the species that I identify as *A. grisellus,* which latter two are separated at once by their constant color differences. Six of the paratypes are from the Hopping collection and came originally from the C. W. Leng collection. This series was labeled, apparently by Mr. Leng, "Attalus n. sp." I do not feel justified in calling the present form a subspecies, since typical *A. oregonensis* also occurs in the same locality as the type series.

The form is named in honor of my wife, who has been my companion on many collecting trips and who has put up with my "beetleing" for the past twenty years and more.

Attalus rostratus Horn

This species has been included in the key, until such time as I am able to examine Horn's unique female type. Fall (1917) considered it "more than likely that the male will show this to be a *Tanaops.*" Two female specimens in my collection, which I obtained several years ago under the name *A. rostratus,* from the Los Angeles Museum, proved to belong to *Tanaops neglectus* Marshall (1946) and two females in Mr. Frost's collection, one identified by F. Blanchard and one by Chas. Dury are, respectively, females of *T. neglectus* and *T. greeni* Marshall (1944).

Attalus diffusus Marshall, new species

Male. Elongate-oblong, very slightly widened posteriorly. Blackish piceous, lateral and apical elytral margins diffusely paler, prothorax, anterior two pairs of coxae and trochanters and the entire abdomen rufotestaceous. *Head* short, eyes prominent, length-width ratio 0.92, front bi-impressed, surface shining, very finely and sparsely punctured and pubescent, more densely so in the impressed areas. *Antennae* long, reaching about the middle of the elytra, feebly serrate, moderately pubescent. *Prothorax* transversely oval, one-fifth wider than long, the angles all strongly rounded, surface shining, punctuation and pubescence as on the head, with a scattering of erect, anteriorly inclined, black setae. *Elytra* minutely tuberculate, with a peculiar greasy luster, which is both alutaceous and sericeus, the tips separately rounded, the pale decumbent pubescence very dense, the erect black setae numerous and evenly distributed. Pale lateral margins very narrow, except where slightly dilated just anterior to the middle; pale apical margins wider. Pygidium exposed between the elytral tips, small, the sides straight and converging posteriorly, the apex truncate and shallowly emarginate. *Under surface* densely and finely punctate and pubescent, the fifth sternite broadly impressed and shining each side of the midline, the sixth consisting of two small rounded lateral lobes, which leave about half of the ventral surface of the pygidium exposed. Lobes of the second protarsal segments long, completely covering the third segments, with the tips narrowly rounded and margined with black.

Female. Similar to the male, except as follows. Proportionately broader, the elytra more evenly convex and slightly more widened posteriorly; the diffusely pale apical margin very narrow; antennae shorter, passing the posterior thoracic margin by not more than one segment and very feebly serrate; abdominal segments black, except for the membranous portions and margins, which are rufopiceous; the last sternite concave and longitudinally impressed in the midline; the pygidium larger than in the male, with the tip more rounded and more acutely notched.

Length, male 2.0 mm., female 2.5 mm.

Holotype, male, "**Dragoon Mts., Ariz.,** IX–10–47. D. J. and J. N. Knull, collectors" and allotype, female, "Douglas, Ariz., VIII–11–40. E. S. Ross, collector." Holotype in collection of Ohio State University, allotype in that of the California Academy of Sciences.

Originally described from the unique male holotype and later 30 specimens, 10 males and 20 females, were received from the California Academy of Sciences. In addition to the allotype, these 29 paratypes are from Douglas, Tucson, Patagonia, and Huachuca mountains, Arizona, and from Guaymas, Sonora, Mexico. Paratypes in the author's collection and in those of the institutions just mentioned.

The series shows considerable variation. In some males, the labrum, clypeus, genae, mesosternum, and proximal half of the femora are testaceous, as well as the parts mentioned in the type, while in others of the same sex the abdominal segments are indistinctly maculate with piceous and the pale margins are reduced to the condition seen in most females. In four males and two females the pronotum is black, with broad lateral and posterior margins testaceous. The females run darker than the males and in most of them the pale elytral margins are reduced to the anterior half of the lateral margins. The abdominal segments are black, as in the allotype, in all but two of the female paratypes. In one of the males, the suture is narrowly pale in the posterior half and in another an indistinct, piceotestaceous transverse fascia occupies the middle third of the elytra.

The species is apparently allied to *A. dilutimargo* Fall, especially in the diffuse blending of the elytral margins and disc and the small size. *Attalus dilutimargo,* however, has the sutural margins of the elytra pale and the tips not pale, whereas the opposite is present in *A. diffusus.* It also appears to be related to *A. opacipennis* Champion (1914), described from a unique female from an unknown locality in Mexico. *Attalus opacipennis* is said to have the elytra entirely black and the thorax, as well as the elytra, "densely alutaceous." In none of the specimens of *A. diffusus* are the elytra entirely black and the thorax is shining. *Attalus opacipennis* is also larger, 3.0 mm.

Attalus circumscriptus Say

Neither Say (1823), in his original description of this species, nor Horn (1872) nor Blatchley (1910), in their subsequent descriptions, gave any indication of the considerable variation in size or the differences in color associated with sex. These authors evidently drew their descriptions from the female, as they state that the head is black, with only the epistoma testaceous. The males have the yellow trilobed frontal area which is seen in the males of several other species of the genus. The legs in the females are about as described by Horn, with the hind pair piceous, but in the males all the legs are yellow. The males vary in size from 2.0 to 3.0 mm. and the females from 2.5 to 3.75 mm.

Attalus lobulatus Leconte and **Attalus difficilis** Leconte

There are several minute species in the *A. difficilis-lobulatus* group to be worked out. In most of the collections that I have examined, I believe that these two species are usually misidentified. *Attalus difficilis,* according to both Leconte and Horn, is about 3.5 mm. in length, but the species that I have seen commonly bearing that name, mostly from Utah, is a species about half that length. The form that is usually taken for *A. lobulatus* is, I believe, the one that was mentioned by Leconte as a variety of that species, common throughout southern California, but which I believe to be distinct. I have recently been able to compare specimens from Congress Junction, Arizona and from Yuma, Arizona, with Leconte's types of *A. difficilis* and *A. lobulatus,* respectively and found them to be identical. The type of *A. difficilis* is a female. The type series contains four specimens, the other three of which belong to a different species. The type of *A. lobulatus* is pale, with a trilobed black spot on the thorax. Still another closely related species, with entirely pale head, thorax and underparts, occurs in the mountains near Globe, Arizona. Since all of my specimens of Leconte's "*lobulatus* variety" are females, I will not describe that form at the present time, but will describe the form just mentioned as "mostly from Utah," under the name *A. utahensis.*

Attalus utahensis Marshall, new species

Male. Elongate oblong, slightly widened posteriorly. Color piceous; head, thorax and basal fourth of elytra blackish; clypeolabral membrane, membranous central portion, and posterior margins of abdominal segments whitish; under surface of first five antennal segments, genae, mandibles, narrow basal margin, and posterior angles of thorax, and entire narrow elytral margins testaceous; tibiae, tarsi, and anterior two pairs of trochanters piceotestaceous. *Head* short, length-width ratio 0.91, anterior half of the front distinctly bi-impressed, with a faint rounded impression midway between the eyes; surface moderately shining, minutely punctulate and with fine, pale pubescence. *Antennae* feebly serrate, moderately pubescent, passing the thoracic base by about three segments. *Prothorax* quadrate, one-tenth wider than long, the sides slightly converging posteriorly, all the angles rounded; surface unusually convex, the anterior margin prominent and arcuately produced; punctuation and pubescence as on the head. *Elytra* with narrow, uniform, sutural, apical and lateral margins testaceous, the sutural margin reaching the scutellum; surface shining, very slightly roughened, the punctures sparse and minute, the pubescence sparse and pale, with a few inconspicuous longer erect hairs along the lateral margins. *Ventral surface* sparsely pubescent, the legs somewhat more so. Lobes of second protarsal segments covering about one-half the third, the ends rounded, broadened distally, the margins narrowly black. Pygidium triangular, the sides almost straight, meeting at the tip in an acute angle. Last ventral segment divided into two oblique corneous lobes, the posterior edge of the fifth segment deeply and angularly emarginate.

Female. Similar to the male in form, color and surface sculpture. Antennae shorter, scarcely serrate, passing the thoracic base by two segments. Pygidium parabolic, the tip rounded; last sternite with a deep longitudinal impression occupying the entire central third of the segment, the bottom of the impression smooth and impunctate.

Length, male and female, 2.0 mm.

Holotype, male and allotype, female, "**Beav. Crk. Hills, Beaver Co., Utah**"—no dates or collector's labels—in the author's collection. Paratypes are in the author's collection and in that of the California Academy of Sciences.

Described from a series of 15 specimens, 6 males and 9 females; 3 collected at the above locality, 4 from ''Nephi, Utah,'' 2 from ''Ogden, Utah,'' and one each from ''Deer Creek, Provo Can., Utah,'' ''Cedar City, Utah,'' ''Wendover, Utah,'' ''Mt. Home, Idaho,'' ''Tucson, Ariz.,'' and ''Esmeralda Co., Nev.''

The variation shown in the series is small. In several, the pale posterior margin becomes so narrow as to be almost invisible. The pale sutural elytral margin is very slightly dilated at times and does not quite reach the scutellum. In the male from Tucson, which may be distinct, three tergites are exposed beyond the elytra and the pygidium has the tip truncate.

This species must be separated from *A. difficilis, A. lobulatus,* and *A. texanus. Attalus difficilis,* under which name the species now stands in the collection of the U. S. National Museum, is a larger species, 3.5 mm. long, the pale sutural margins of the elytra are strongly dilated, the elytral apices broadly pale, the entire lateral thoracic margins pale, the posterior angles broadly so, the anterior half of the head, anterior two pairs of coxae and femora, and the pro- and mesosterna are yellow and the last sternite of the female is unmodified. *Attalus texanus* is about the same size as *A. utahensis,* at least in the male, but also has practically the same distinguishing points as *A. difficilis,* except that the thorax is pale, with a median black stripe; the head of the female is black, that of the male is yellow anteriorly, with a trilobed pale frontal area. Typical *A. lobulatus* is a pale species (Leconte says ''flavus'' in the original description), with a trilobed discal black spot on the prothorax. The dark variety mentioned by Leconte resembles the present species more than any other and may possibly bear a subspecific relation to it. All the specimens that I have seen, possibly a dozen, have been females, as are the four in my collection from Bailey's Well, San Diego County, California. In all of these, the pale sutural margins of the elytra are strongly dilated and depressed, the depressed area evenly rounded anteriorly and not extending any farther forward than the anterior fourth of the elytra. The depression on the last sternite is shallow and rounded.

Attalus cinctus Leconte

Typical *A. cinctus,* as shown by specimens in my collection which I have compared with Leconte's type, has the thorax black, with the entire elytral margin, including the base, narrowly yellow. The thorax may have a very narrow entire yellow margin or this may be confined to the base, as stated by Horn (1872). A female, in my collection, from Prescott, Arizona, has the thorax rufous, with three black discal spots and the head entirely pale, except for a slight darkening of the occiput; one, also a female, in the collection of Mr. J. W. Green, has the head and thorax entirely pale. In both specimens there is a considerable widening of the pale sutural margin anteriorly. These specimens closely resemble, so far as color is concerned, certain specimens of *A. rufiventris,* but may be easily distinguished by the much larger pygidium in *A. cinctus,* in both sexes. They also resemble *A. tucsonensis,* but lack the deep pygidial notch of the female of that species.

Attalus scincetus Say

The black dorsal thoracic spot or stripe, as it has been variously designated, becomes widened in many specimens and in a few (approximately 10 percent in a series of 50 specimens before me) comes to occupy the entire thorax, with the exception of the posterior angles. In one specimen, even these are black. In such cases, the black color of the occiput extends down the head for a variable distance, at times as far as the lower border of the eyes, and the abdominal segments and femora become piceous. Most, but not all, of these dark specimens are females. All degrees of intermediate stages of both Motschulsky's variety *"infuscatus"* and Blatchley's variety *"confusus"* occur and it is not thought that either of these names is entitled to varietal rank, strictly speaking. However, the concept of a variety is less well defined than that of a subspecies, there being almost as many concepts of what constitutes a variety as there are writers on the subject. Some taxonomists have even gone so far as to suggest that the category be abandoned altogether. It appears that its claim to survival rests not so much on its scientific accuracy as on its practical usefulness in giving us a short, convenient method of referring to things which would otherwise require more or less circumlocution. The average coleopterist would like to be able to identify at least the bulk of the material in his collection without the necessity of sending his specimens to a specialist and if marked variations from the usual appearance of a species, which are apt to lead him astray in his attempts at identification, can be given a name, they can be more easily incorporated into keys and thus called to his attention. *Attalus s. confusus* Blatchley, which is certainly well named, offers an excellent illustration of the point I am trying to make. I have seen scarcely a collection in which one or more specimens of this so-called variety were not set aside in the unidentified material and, I may as well confess, I was in the process of describing one unusually dark specimen as new, when it suddenly dawned on me what I was dealing with. Blatchley (1910) gives very little idea of the extent of variation shown when he defines his *"confusus"* as "a color variety of *scincetus* in which the elytra, except the tips, are wholly piceous black and the median black stripe of thorax usually a little broader." In the specimen referred to, the entire thorax and elytra are black, except for the merest suggestion of a yellow margin at the posterior thoracic angles. The color pattern of the head is also very unusual, two diverging finger-shaped piceous areas extending down into the yellow portion of the lower front. Specimens occur, at Dunedin, Florida, which are entirely pale, except that the usual black thoracic stripe is outlined by a piceous rectangle, pale in the center.

Attalus trimaculatus Motschulsky

This species approaches *Tanaops* in characters other than that of the elongate head. The second protarsal segment in the male, while it projects over the third, does not cover more than one-half the latter segment and does not show the sharply defined, black edge at the tip so common in *Attalus*. The fifth abdominal segment has an impressed groove just anterior to the posterior margin, both borders of the groove acutely angulated anteriorly at the midline and the fourth segment has a similar, though fainter, groove, evidently the homologue of the ventral pits seen in the males of *Tanaops*. A pair from Redlands, California, appear to possess all the characters of the above species, except that the male has a different type of modification of the 5th sternite, of which the posterior margin is markedly thickened and bristly in the lateral thirds, with the remainder of the segment deeply and transversely excavated. This is evidently a distinct species, but one cannot be certain, without examining Motschulsky's and Horn's types of *A. trimaculatus* and *A. elegans,* which of them is *A. trimaculatus* or whether one is *A. trimaculatus* and the other *A. elegans,* which Horn (1872) placed as a synonym of *A. trimaculatus.*

Attalus subtropicus Marshall, new species

Male. Elongate-oblong, scarcely widened behind. Color testaceous, the head posterior to a line connecting the center of the eyes, upper surface of the antennal segments, a broad median thoracic stripe, a broad vitta on each elytron, palpi, metasternum, a pair of lateral spots on each of the first two abdominal segments, and the last two tergites (except for the lateral margins) piceous; the labrum, tibiae, tarsi, and distal end of the femora piceo-testaceous. *Head* slightly elongate, the length-width ratio 1.19, front practically flat, a small foveiform impression between the eyes; surface shining, finely punctulate and with fine pale pubescence. *Antennae* short for the genus, not passing the thorax by more than two segments, moderately serrate and pubescent. *Prothorax* almost circular in outline, viewed from directly above, 1.15 times wider than long; surface and pubescence as in the head, with a very few scattered erect setae. *Elytra* practically parallel, the piceous vittae narrowed from both sides just anterior to the middle, not quite reaching the lateral margin posteriorly and more remote from the sutural and apical margins; surface shining, finely and rather densely punctulate, the pale pubescence fine, semierect and inconspicuous, no erect setae clearly distinguishable from the balance of the pubescence. Last two tergites exposed beyond the elytra, the pygidium acutely and angularly emarginate at the tip. *Under surface* finely punctured and pubescent, the abdomen unusually long and narrow, practically cylindrical beyond the third segment. The fifth sternite has a pair of very deep, transverse pits, narrowly separated in the midline and extending to the extreme lateral margin, the upper edge sharp and overhanging; the sixth is composed of a pair of lateral lobes, which leave about half the ventral surface of the pygidium exposed. The lobes of the second protarsal segments are obliquely narrowed toward the tips, which are very narrowly margined with black.

Female. Similar to the male, except that the antennae are very short, scarcely reaching the thoracic base, feebly serrate; all the legs and the sides of all the abdominal segments are piceotestaceous. The pygidium is more pointed than in the male, but has a similar apical notch; the last sternite is flatter than usual, impressed in the midline and thickened along each lateral margin.

Length, male and female, 2.7 mm. to tips of elytra.

Holotype, male, "**Brownsville, Texas**, V–26–03" and allotype, female, "Esperanza Rch., Brownsville, Tex. V–25–03"—no collector's label on either specimen—in the author's collection.

Two paratypes, one male, one female, same data as allotype, in collection of Mr. C. A. Frost.

Three of the above four specimens, from Mr. Frost's collection, were labeled "Horn's rufiventris var.?, Vidit H. C. Fall, 1936." The species resembles the variety of "*rufiventris*" mentioned by Horn (1872) with respect to its color, but may be distinguished at once by the prominent abdominal pits of the male and the pointed, acutely notched pygidium of the female. The paratypes do not show any variation of consequence.

Attalus santarosae Marshall, new species

Male. Elongate-oblong, very slightly widened posteriorly. Black, the anterior half of the head, thorax, elytral margins, and most of the ventral surface rufotestaceous. *Head* long, length-width ratio 1.17, rufous anterior to a line connecting the center of the eyes. The line of demarcation is posteriorly arcuate and from its central portion a small reddish triangle extends up into the black area. Lower portion of front and clypeus very shining and glabrous, the remainder less shining, minutely punctulate and with fine, sparse, decumbent, pale pubescence; front flat, unimpressed. *Antennae* moderate in length, passing the thoracic base by about two segments, feebly serrate, moderately pubescent, the ventral surface of the first three segments testaceous. *Prothorax* quadrate, one-tenth wider than long, the sides slightly converging posteriorly, the angles all broadly rounded, the posterior slightly reflexed; surface shining and glabrous, the prostrate pubescence so fine as to be almost invisible, a moderate number of conspicuous, erect, black setae uniformly distributed over the surface. *Elytra* black with an aeneous tinge, the entire lateral, apical, and sutural margins testaceous, the lateral and sutural slightly dilated just anterior to the middle, apices separately rounded, surface shining, punctuation distinct, fine and moderately dense, pale prostrate pubescence fine and inconspicuous. The evenly distributed, numerous, erect, black setae, however, are conspicuous and produce a bristling appearance. Pygidium moderate in size, strongly converging posteriorly, the tip truncate, entire. *Under surface* uniformly rufotestaceous, except the outer half of the metepisterna, the tibiae and tarsi and the distal ends of the femora, which are piceous; finely punctate and pubescent, the fourth and fifth sternites glabrous and shining and each with a pair of small, poorly defined pits at the posterior margins, the sixth consisting of a pair of short rounded lateral lobes. Lobes of the second protarsal segments long, narrow, tapered to a sharp point at the apices and without the usual black margin.

Female. Similar to the male, except as follows. Antennae slightly shorter and more feebly serrate; lateral and sutural margins of elytra less definitely dilated before the middle, almost uniform in width; head black almost as far anteriorly as the clypeal suture; last sternite piceous and unmodified, slightly shorter than the pygidium, which, together with the central third of the propygidium, is piceous and resembles that of the male in shape and size.

Length, male 2.7 mm., female 2.9 mm.

Holotype, male and allotype, female, "**Santa Rosa Mts., Cal.,** VI–15–46. D. J. and J. N. Knull, Collrs." The types are the property of Ohio State University and will be deposited in that institution.

Described from a series of 16 specimens, 11 males and 5 females, 8 with the same data as the types, 8 collected by Dr. W. F. Barr at Piñon Flat, San Jacinto Mountains, California. In addition, there are some eight or ten specimens of the same series that I returned to Ohio State University some time ago determined as *A. rufomarginatus* Motschulsky. These may also be considered as paratypes. Paratypes are retained in the author's collection and in that of Dr. Barr.

Several of the paratypes have a nubilous piceous spot on the anterior portion of the thoracic disc and in several the greater part of the femora is piceous, especially along the dorsal edges. In one male the central portions of the pygidium and propygidium are piceous. The palpi are uniformly piceous. In some of the females, the piceous color of the last sternite is confined to the apical half. The females, in general, tend to be darker than the males, although in some the color pattern of the head resembles that in the males. In one female a central narrow longitudinal piceous stripe runs from the tip of the labrum past the anterior border of the eyes.

As already indicated, at one time, before I had obtained Motschulsky's (1859) paper in which he described and figured *A. rufomarginatus,* I identified the present species as such, partly by exclusion and partly from the fact that I had seen specimens of the species so identified by Professor Fall. Reference to the original description of *A. rufomarginatus,* quoted below, will show that that species is larger, has the thorax black with broad lateral pale margins, the abdominal segments black with the margins rufescent, front transversely impressed, and the elytra impunctate. I do not attach much weight to the color differences, but no one could possibly describe the elytra of the present species as impunctate, as the punctures are numerous and clearly discernible even with an ordinary 14 X hand lens.

Attalus rufomarginatus Motschulsky

This species has never been definitely identified in this country since Motschulsky (1859) described it. I know of only two references to it in our literature. Horn (1872) omitted the species from his key, merely stating that it resembled *Tanaops abdominalis.* In 1917, Fall stated that specimens identified by Horn, both in the Leconte collection and in his own, were *T. abdominalis.* He stated further that from Motschulsky's description there could be no doubt that *''rufomarginatus''* was a true *Attalus.* I am unable to follow his reasoning here, since Motschulsky definitely describes a female and makes no mention whatever of the male. It is true that in his description of the genus *Scalopterus,* in which he placed *''rufomarginatus,''* he states that the second segment of the anterior tarsus is prolonged into a hook (''crochet''), which covers the two following segments, but it seems unlikely that, if he had possessed a male of *''rufomarginatus,''* he would have made no mention of it. In the collection of Mr. C. A. Frost are six specimens, three males and three females, identified by Dr. Van Dyke as *''rufomarginatus?''*. I can see no difference between these and *T. abdominalis.*

Since the original description is difficult to obtain, I reproduce it here, translated from the Latin of Motschulsky:

> "118. *Scalopterus rufomarginatus* Motsch. Female winged, elongate, posteriorly dilated, subdepressed, shining, with very short cinereous pubescence, black, the front, second joint of antennae, the sides of the thorax very broadly, the margin and suture of the elytra posteriorly, rufous, the anterior tibiae and the margins of the abdominal segments more or less rufescent; front between the eyes transversely impressed, antennae subserrate, the second joint short, the third equal to the first; thorax subelongate-rounded, margined, impunctate, the median line scarcely distinct; elytra about as wide as the thorax, anteriorly subparallel, posteriorly dilated, the apex broadly rounded, coriaceous, impunctate, the humeri distinct; abdomen coriaceous, finely punctate.
>
> "Length, 1½ 1. (3.4 mm.)—width 2/3 1. (1.5 mm.)
>
> "Plate IV, fig. 27."

Since *T. abdominalis* has been so persistently identified as *A. rufomarginatus,* the possibility that Motschulsky's type was a female of that species, of whose description he was obviously unaware at the time, should be considered. Reference to the above description will show that *A. rufomarginatus* possesses the following characters, either explicity stated or clearly implied. Antennae black, except the second segment, which is rufous; legs all black, except the anterior tibiae, which are rufescent; abdominal segments black, except for the margins, which are more or less rufescent; elytra impunctate. None of these characters is present in any specimen of *T. abdominalis* that I have examined. My present series of *T. abdominalis* contains 20 specimens and I have examined more than a hundred others in the last two or three years, but I have never seen one with a black abdomen. It would be unsafe to assert that such a variation does not exist, but the chance that Motschulsky was dealing with such a rarity is too remote to be given serious consideration. Like Fall (1917), I had three species, one of which I hoped would prove to be *A. rufomarginatus.* One of these was *T. abdominalis,* the second *T. neglectus* Marshall, and the third the species that I have just described as *Attalus santarosae.* The differences between this last species and the description of *A. rufomarginatus* are emphasized in the notes following the description of *A. santarosae.*

A series of ten specimens, from Paraiso Springs and Pasadena, California, contains some which correspond almost exactly to Motschulsky's description of *A. rufomarginatus* and I think are probably that species. The single male in the series is, however, definitely a *Tanaops.* If my identification is correct, which cannot be definitely proven or disproven until Motschulsky's type is available for inspection, the species should be transferred to *Tanaops.*

Attalus difficilis Leconte

See remarks under *A. lobulatus* and *A. utahensis.*

Attalus rufipennis Gorham

Gorham's variety "N" of this species, with "head and thorax black, elytra red, unspotted" occurs on Ceralbo Island, near LaPaz, just off the coast of Lower California and thus should be added to our official lists, which include Lower California.

MEXICAN SPECIES

The two following Mexican species were included in material sent me for identification by the California Academy of Sciences and are herewith described, so that the types may be returned to the Academy. The one species of *Attalus* is not included in the above key and I have not been able to assign it to any of the species treated by Champion (1914) in his revision of Mexican and central American Malachiidae.

Attalus limonis Marshall, new species

Male. Oblong-ovate, the elytra moderately and uniformly widened posteriorly, the dilatation commencing just behind the humeri. Black; head anterior to a line joining the center of the eyes, broad lateral thoracic margins, all the elytral margins except the basal, four basal antennal segments, prosternum, anterior trochanters, last four abdominal segments, and central portion of posterior tibiae rufotestaceous. *Head* short and broad, inserted in the thorax to the eyes, front unimpressed, surface shining, very minutely and sparsely punctulate and pubescent. *Antennae* long, reaching the middle of the elytra, strongly serrate and pubescent. *Prothorax* transversely oval, 1.3 times wider than long, the anterior margin slightly produced; surface, punctuation and pubescence as on the head; rufotestaceous, with a large black, triangular discal spot, the base of the triangle occupying the central third of the anterior margin, its apex at the center of the posterior margin. *Elytra* shining, punctures fine and rather sparse, but much more prominent than on head and thorax; pale semi-erect pubescence rather sparse and inconspicuous, no erect black setae present. The pale sutural margin reaches about three-fourths the distance from apex to base and is widened near its anterior end, opposite a corresponding dilatation of the lateral margin, which is obsolete at the base and near the apex. Apices broadly pale. Pygidium small, piceous except at the lateral margins, quadrangular, truncate at the tip. *Under surface* and legs finely and sparsely punctate and pubescent. Anterior tarsus (the right missing) of unusual structure, the first and third segments elongate, the third apparently inserted on the tip of the first, the second inserted on the anterior face of the first at about its middle, its free lobe laterally compressed or twisted and extending over the third almost to its apex, the usual black margin of the lobe extremely fine. Abdominal segments with no distinctive modifications.

Female. Similar to the male, except as follows. Antennae much shorter, scarcely passing the thoracic margin and very feebly serrate. Head entirely pale, except the occiput; prothorax entirely pale; elytra definitely more dilated behind. Pygidium triangular, the apex narrowly rounded and with a small, acute notch at the tip. Last sternite with a median linear impression, the lateral areas tumid, piceous, more coarsely punctured and hairy.

Length, male 2.5 mm., female 2.7 mm.

Holotype, male and allotype, female, labeled "**20 mi. n. El Limon, Tmlps., Mex.**, XI–10–46. E. S. Ross, Collector." Types in collection of California Academy of Sciences.

One female paratype, same data, in author's collection. The paratype has the head and thorax entirely pale and the black elytral vittae are almost divided by the dilatation of the sutural and lateral pale margins.

The species resembles in its color pattern, both *A. albomarginatus* Champion (1914) and *A. viridivittatus* Champion (1914), each described from a unique male. These species are both smaller than *A. limonis,* not over 2.0 mm. *A. albomarginatus* has the elytra ''fusco-violaceous,'' with the margins whitish, the head densely punctate and shallowly foveate between the eyes, the antennae feebly serrate; ''the femora are black, with the apices abruptly testaceous and colored like the tibiae.'' *A. viridivittatus,* which I have from Cuernavaca, Mexico, has the head foveate between the eyes, the legs testaceous, the elytral vittae green and the elytra ''set with intermixed long semi-erect hairs.''

Sphinginus Rey

This name was proposed by Rey *(in* Mulsant and Rey, 1867), as a subgenus of *Attalus* and erected into a separate genus by Abeille de Perrin (1890). It contains four species from the Mediterranean region, one from the Canary Islands, and one from Guerrero, Mexico, described by Champion (1914). The present species is very close to *S. eburatus* Champion, differing mainly in that the thorax is black instead of rufous and the transverse elytral fascia is yellow instead of white, is broader than in *S. eburatus,* which is figured by Champion, and is not raised or eburate. The genus is separated from *Attalus* by the elongate, posteriorly narrowed thorax.

Sphinginus mexicanus Marshall, new species

Female. Elongate, narrow, opaque, elytra scabrous. Black, an antemedian, interrupted, transverse elytral fascia and the posterior two-fifths of the suture, excepting the apex, yellow; tibiae and tarsi piceous. *Head* large, oval, one-tenth longer than wide, tempora strongly produced behind the eyes and converging, the front faintly bi-impressed; surface strongly alutaceous, punctures not evident, pubescence extremely fine and sparse. *Antennae* short, about reaching the posterior thoracic margin, scarcely serrate, moderately pubescent. *Prothorax* trapezoidal, length and width equal, anterior margin broadly arcuate, sides rounded in front, strongly converging and slightly sinuate toward the base, which is squarely truncate, with the basal margin strongly reflexed; sculpturation and pubescence as on the head. *Elytra* with a violaceous tint, moderately widened behind, densely scabroso-punctate, smoother near the apices, the pale pubescence very fine, sparse and inconspicuous, the erect black setae numerous and evenly distributed. The transverse yellow spot on each elytron extends from the lateral margin about two-thirds the way to the suture and is about twice as wide as long. Two tergites are exposed beyond the elytra; pygidium quadrate, with apex truncate and slightly emarginate. *Under surface* shining, very finely and sparsely punctulate and pubescent, the last sternite with a semicircular emargination at the apex. Length 2.0 mm.

Male unknown.

Holotype, female, labeled "**5 mi. S. Cuernavaca, Mex.,** XI–19–46. E. S. Ross, Collector," in the collection of the California Academy of Sciences.

One female paratype, which does not show any variation worth noting, in the author's collection.

Carphuroides Champion

The genus *Carphurus,* established by Erichson in 1840, together with several other satellite genera, now forms the subfamily Carphurinae, which is characterized mainly by the presence of a black comb along the inner edge of the male first protarsal segments and which has its habitat in Australia and the Indo-Malayan region. One of the genera, *Carphuroides* Champion (1923) is distinguished chiefly by the structure of the male protarsi, segments two to four being narrow and obliquely prolonged beneath the following segments, whereas in *Carphurus* segment four is broadly dilated laterally to form a flattened emarginate lobe beneath the claw segment. Champion designated the genotype of *Carphuroides* as *Helcogaster pectinatus* Sharp, from Hawaii. The genus contains one species each in Rhodesia, Central America, Hawaii, and Japan, the remainder of the rather numerous species occurring in the Indo-Malayan region. The Central American species is *Helcogaster atratulus* Gorham (1886), described from two specimens, one from Panama, the other from Guatemala and not mentioned since in the literature, so far as I know. This was placed in *Carphuroides* by Champion at the time the latter genus was erected.

Carphuroides atratulus (Gorham)

A single male specimen, from Ceralbo Island, in the Gulf of California, near LaPaz, Lower California, is either this or a very closely related species, the only noteworthy difference between it and Gorham's description being that the Lower California specimen has the basal third of the elytra testaceous. Considering the extreme color variability in so many of the species of *Malachiidae* and the impossibility of comparing it with Gorham's types at the present time, I do not feel justified in describing it as a new species and am reporting it as *C. atratulus.* As pointed out by Champion, both Sharp and Groham overlooked the tarsal comb in *C. pectinatus* (named for the pectinate antennae) and *C. atratulus* and Erichson makes no mention of it in his diagnosis of the genus *Carphurus* or the description of the two species which he included therein. The comb in *C. atratulus* is black, in striking contrast to the testaceous tarsal segments, runs the full length of the first segment, along its inner border, has seven teeth and is about as wide as the segment itself. The species forms an interesting addition to our official list. The specimen in question is in the collection of the California Academy of Sciences.

Finally, for the benefit of future cataloguers, as well as present collectors, I wish to record a number of new localities for many of the species of the family, localities which are in addition to those recorded in the official catalogue (Leng, 1920) and its supplements. The identification of the specimens associated with these localities is either my own or has been checked by me. If some of the localities have been previously published, either by myself or someone else, the repetition of them here will do no harm. The species are listed in the order in which they appear in the Leng Catalogue.

Collops cribrosus Lec., South Dakota; *C. tricolor* (Say), Missouri, South Dakota, Montana; *C. sublimbatus* Schffr., Tennessee, North Carolina; *C. punctatus* Lec., Iowa, South Dakota; *C. dux* Fall, Arizona; *C. marginicollis* Lec., Lower California; *C. reflexus* Lec., New Mexico; *C. hirtellus* Lec., British Columbia, Idaho, Washington, Alberta, California, Nevada, Colorado, Oregon, South Dakota; *C. discretus* Fall, Utah; *C. subaeneus* Fall, Utah; *C. nigriceps* (Say), New York, Mississippi, Georgia; *C. floridanus* Schffr., Louisiana, Texas, Alabama, Mississippi; *C. bipunctatus* Say, Nebraska, South Dakota, Oregon, Idaho, Colorado, Wyoming, New Mexico, Texas, Utah, Mexico; *C. limbellus* G. and H., South Dakota, Texas, Pennsylvania; *C. flavicinctus* Fall, Texas; *C. granellus* Fall, Texas, California; *C. vittatus* (Say), Ohio, Maine, South Dakota, Colorado, California, Lower California; *C. necopinus* Fall, Utah, Arizona, Lower California; *C. punctulatus* Lec., South Dakota; *C. insulatus* Lec., South Dakota, Arizona, Texas, Lower California; *C. utahensis* Schffr., Idaho, South Dakota; *C. texanus* Schffr., Sinaloa, Mexico; *C. histrio* Er., Lower California; *C. similis* Schffr., Arizona; *C. confluens* Lec., Texas, Nevada, California; *C. quadrimaculatus* (Fab.), Tennessee, South Dakota, Nebraska; *C. balteatus* Lec., Alabama, Florida; *C. versatilis* Fall, southern California; *Trophimus impressus* Sz., New Jersey; *Endeodes basalis* (Lec.), Lower California; *Malachius aeneus* (L.), British Columbia; *Anthocomus contortus* (Fall), Alberta; *A. horni* (Fall), Washington, Oregon, Idaho, Arizona; *A. mirandus* (Lec.), Washington; *A. theveneti* (Horn), Idaho, Oregon, Nevada; *A. mixtus* (Horn), Oregon, Idaho, British Columbia; *A. ulkei* (Horn), Wisconsin, Colorado, South Dakota, Quebec; *A. montanus* (Lec.), Colorado, Arizona; *A. floricola* (Martin), British Columbia; *A. antennatus* (Hopping), Nevada; *A. moerens* (Lec.), Oregon; *A. erichsoni* Lec., Manitoba, Texas; *A. flavilabris* (Say), North Carolina; *A. bipunctatus* Harrer, Pennsylvania, District of Columbia, New Jersey; *Tanaops terminalis* Fall, Arizona; *T. dubitans* Fall, Arizona; *T. mimus* Fall, Arizona, New Mexico, Texas, Sonora; *T. coelestinus* Gorh., New Mexico; *T. basalis* Brown, Oregon, Wyoming, Montana; *T. oregonensis* M. Y. Marsh., California; *Pseudebaeus bicolor* (Lec.), California, Oregon, British Columbia, Saskatchewan; *P. pusillus* (Say), New York; *Attalus serraticornis* Fall, Arizona, Texas; *A. dimidiatus* Fall, Lower California; *A. oregonensis* Horn, Arizona, Nevada, Lower California; *A. lecontei,* Champ., Colorado, New Mexico; *A. glabrellus* Fall, Arizona, Texas, Colorado; *A. terminalis* (Er.), New York, Ontario, Maryland, Tennessee, Michigan, Massachusetts, New Jersey, Manitoba, Minnesota, Iowa, Maine, Pennsylvania, South Dakota; *A. varians* Horn, Arkansas; *A. futilis* Fall, Arizona, Texas; *A. grisellus* Fall, Texas, South Dakota, Saskatchewan; *A. morulus* (Lec.), Colorado, Arizona, New Mexico, Utah, California, Nebraska, (Eastern records are for *A. greeni* Marshall or *A. frosti,* new species); *A. pallifrons* (Mots.), Kentucky, Pennsylvania, Illinois, Ohio, Mississippi, Saskatchewan; *A. semirubidus* Fall, Mississippi, North Carolina, Florida; *A. humeralis* Lec., Texas; *A. pettiti* Horn, Ohio; *A. rufiventris* Horn, New Mexico, Utah, California, Lower California, Sonora; *A. nigripes* Horn, Arizona, Oklahoma, South Dakota, Sonora; *A. otiosus* (Say), South Dakota; *A. circumscriptus* (Say), Texas; *A. cinctus* (Lec.), Lower California; *A. difficilis* (Lec.), Nevada, Colorado, Lower California; *A. lobulatus* (Lec.), Lower California, Sonora; *A. scincetus* (Say), Texas, South Dakota, Iowa, Kansas, Tennessee; *A. smithi* Hopping, Idaho; *A. texanus* Marshall, New Mexico, Texas, Colorado, California; *A. greeni* Marshall, Virginia, West Virginia, Tennessee, Pennsylvania, New Jersey, Maryland.

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ON THE NATURE AND FUNCTION OF "CHALKY" DEPOSITS IN THE SHELL OF OSTREA EDULIS LINNAEUS

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INTRODUCTION

Our textbooks of zoology, dealing with the anatomy of Lamellibranchia, usually state in describing the structure of the shell that each shell consists of three layers: a thin outer "horny" layer (periostracum) of purely organic nature (conchyolin); next a calcareous layer consisting of prisms placed vertically; and further a thinner or thicker inner nacreous layer, consisting of thin lamellae placed horizontally, and sometimes displaying a delicate lustre.

Many zoologists are not aware that this scheme, based on the anatomy of *Anodonta,* does not always hold good in other species of lamellibranchs. In fact the exceptions are far more numerous than the species which follow this scheme. A periostracum is not always conspicuous, layers of prisms are quite rare in the realm of the lamellibranchs, and only a few families possess a layer of real nacre (consisting of aragonite). Instead of nacre one often finds a sub-nacreous layer (made of calcite and without the peculiar lustre), or the so-called crossed-lamellar layer.

Not every investigator working with oysters has found time to study the shell structure of these animals in detail, or to read what others have already recorded about it. Thus we can easily understand that mistakes are often made when an author tries to force his findings into the textbook scheme.

The Structure of the Oyster Shell

In the shell of the oyster one can distinguish the following elements:

A. *The periostracum.* Generally the outer margin of the mantle of a lamellibranch mollusk is connected with the free edge of the shell by a sheet of conchyolin. During shell growth this sheet, the periostracum, is continually produced in the furrow between the outer and middle folds of the mantle edge. As this proceeds the mantle is enabled to protrude from the shells when held ajar. Then the outer fold of the mantle edge can start secreting layers of calcareous material on the outer sheet of the doubled periostracum, thus enlarging the shell. In this way the outermost layer of the shell necessarily comes to consist of the periostracum itself. Further, the ever-present periostracum insures an appropriate isolation of the shell-secreting outer fold of the mantle edge, thus preventing the calcareous deposits from being washed away while still in liquid form.

Curiously enough, the oyster at first sight does not appear to possess a periostracum, and its mantle edges appear to be capable of free movements to and from the shell's free edge, apparently not hampered by a trammeling periostracum. This misled many an investigator. Very few observed the oyster's periostracum, this being extremely thin and hyaline and, moreover, very elastic. It is easily overlooked but always present. Its elasticity leaves the mantle considerable freedom of motion and yet offers the required degree of isolation to the shell-secreting tissues. As far as I am aware, Leenhardt (1926) in his excellent pioneering study of the microscopic anatomy of the Portuguese oyster, *Gryphaea angulata,* was the first to demonstrate the presence of a true periostracum in oysters. Serial sections revealed its production in the outer furrow of the mantle edge. In his description Leenhardt (possibly under the influence of the treatise of Rawitz, 1888) made a minor mistake by supposing the wrong epithelium to be responsible for a thickening of this periostracum. I have been able to check in my own serial sections *(Ostrea edulis)* that it is the inner epithelium of the outermost fold of the mantle edge which does this thickening, and not the ciliated outer epithelium of the middle fold, as Leenhardt suggested. Ranson (1939, 1943) describes the periostracum of *Ostrea edulis* as it appears *in situ,* and points out its extreme tenuity (''épaisseur de l'ordre du millième de millimètre''). This led him to call it a pre-periostracum, as no sclerification into a ''true'' periostracum takes place in the oyster. Ranson's description can easily be checked by anyone disposed to observe a living oyster, carefully opened, and placed under water in adequate light. Ranson mentions that von Nathusius-Königsborn (1877) was the first to describe the oyster's periostracum, but I cannot make out from this investigator's paper that he really detected the extremely thin periostracum. There are no indications that von Nathusius-Königsborn ever studied a living oyster or made serial sections of its mantle edge, and only these two methods can lead to a demonstration of the periostracum. Therefore, I believe that Ranson himself was the first to describe a periostracum in *Ostrea edulis,* whereas Leenhardt demonstrated its presence in the Portuguese oyster several years earlier.

B. *Prismatic layer.* Curiously enough, the oyster shows a well-developed prismatic layer only on its right or flat valve. It consists of elastic brown scales placed in imbricate rows all over the outer surface of the flat valve and forms its extreme margin (about 5 to 10 mm. broad), thus contributing to the oyster's faculty of impervious closure. Though several authors (e.g., Orton and Amirthalingam, 1927), mistake this layer of scales for a periostracum, apparently misled by its "horny" appearance, it has repeatedly been stated that this is the oyster's true prismatic layer. Leeuwenhoeck (1682) was the first to detect the prisms, which are placed obliquely in the scales, and are of quite an irregular shape. Later Bowerbank (1844), Carpenter (1845), Rose (1859), and Tullberg (1881) stated that the scales of the oyster's flat valve represent a prismatic layer. Bøggild (1930) in his important work on the shell structure of mollusks, described the oyster's single prisms as curved and reclining in a characteristic manner. Schmidt (1931) studied the minute structure of the prisms and demonstrated that they do not consist of one single crystal of calcite but of a crystal-aggregate. Finally Douvillé (1936) tells us how he witnessed the formation of prisms during shell growth. Personally I repeatedly observed the deposition of the prisms on newly formed lamellae, a sight of great beauty when observed through a petrological microscope.

C. *Subnacreous layer (calcite-ostracum).* By far the greater part of the oyster's shell is constructed of foliated horizontally deposited layers of calcite, for this reason called the calcite-ostracum. It resembles nacre but lacks its beautiful iridescence. Therefore Carpenter (1845) called it the subnacreous layer. Later it was discovered that this subnacreous layer is constructed of fine lamellae of calcite, while true nacre always consists of aragonite-lamellae, arranged in a highly regular manner. Rose (1859) and von Nathusius-Königsborn (1877) state that the lamellae of the oyster's calcite-ostracum show a fine striation, the direction of which varies in alternate layers. Bøggild (1930) classifies the oyster among mollusks possessing shells of foliated structure and states that its separate folia are quite irregularly shaped, while their optical axes show a rather accidental position. As the majority of the folia are placed nearly horizontally, this gives rise to the characteristic pearly lustre of the oyster shell.

D. *Hypostracum.* This layer, described by von Nathusius-Königsborn (1877) and Tullberg (1881), is a rather thin layer in the calcite-ostracum from which it is distinguished by its somewhat different appearance. It is produced under the muscle and thus depicts in sections of oyster shells the course the muscle scar has taken during the life of the oyster. In the oldest parts of the shell this hypostracum is deeply buried under layers of calcite-ostracum subsequently deposited. Generally this hypostracum is somewhat more hyaline in appearance than the rest of the subnacreous layers. In oysters of the *Gryphaea* type, where the muscle scar is pigmented, the hypostracum is seen to traverse the shell layers as a colored band.

E. *Conchyolin sheets.* Sometimes we find thin layers of a greenish or brownish color imbedded in the calcite-ostracum. They are of different sizes and consist of organic material (conchyolin). Often one finds small single calcite rhombohedra imbedded in these layers (Rose 1859). They are secreted by the oyster either as a defense against the intrusion of boring worms *(Polydora ciliata)* or without any obvious reason. In some European oyster districts (e.g., locally in the Basin of Arcachon) such organic layers in the subnacreous material are quite common.

F. *''Chalky''* deposits. A conspicuous characteristic of the oyster shell is the local occurrence of opaque white masses of ''chalky'' appearance and of a soft texture which are imbedded in the harder translucent layers of the subnacreous material. We need not be surprised that many investigators described these ''chalky'' deposits and tried to explain their structure and function.

So far as I am aware, Gray (1833) was the first to record the occurrence of ''calcareous particles deposited in a chalky or concretionary state between the proper laminae of shell structure.'' Later (1838) he added that the ''chalky'' matter is deposited in a succession of plates covered over with harder calcareous plates, more dense and crystalline in their construction. Carpenter (1845) corroborated Gray's observations and commented: ''but I cannot regard such layers as forming part of the proper structure of the shell since the particles of carbonate of lime of which they consist, are not connected by any organic basis.'' Rose (1859) found small calcareous bars and grains in these layers, ''die aber eine regelmässige Form nirgends erkennen lassen'' and criticises the denomination ''chalky deposits,'' as they have nothing to do with true chalk. Von Nathusius-Königsborn (1877) tried to study the minute structure of these deposits but found how difficult it is to produce satisfactory microscopic slides of this material. He persevered, however, and demonstrated that it consists of an irregular and complicated system of septa, predominantly placed vertically, and enclosing a multitude of small air-filled cavities: ''Das ganze Gewebe stellt also ein in verscheidenen Richtungen sich kreuzendes System von zarten Stäbchen oder Fasern dar, die zwar wieder in verschiedenen Richtungen, aber doch in einer dominierenden — der senkrechten — durch Plättchen oder verkalkten Membrane verbunder sind." Clear figures elucidate his findings. Von Nathusius-Königsborn speaks repeatedly of air-filled enclosures, these certainly occur in dry shells in a museum collection, but he did not seem to be aware that under natural conditions these cavities are filled with sea water. Orton and Amirthalingam (1927) state that the "chalky" deposits, though apparently amorphous to the naked eye, appear to have a microcrystalline structure when examined through a petrological microscope. Bøggild (1930) states that it is a characteristic feature of many oyster shells that layers of normal consistency alternate with others more or less porous, which have all their elements placed vertically, while in sections parallel to the surface of the shell these folia are oriented in all possible directions *(Ostrea edulis)*. Ranson (1941) studied intact fragments of these layers with a binocular microscope, and found "très fines lamelles scintillantes, très longues, disposées perpendiculairement aux lames subnacrées limitantes, c'est-a-dire en principe verticalement"; "lamelles empilées irrégulièrement les unes contre les autres"; "elles sont constituées d'une fine membrane calcaire de soutien au sein de laquelle se trouvent de nombreuses fibrilles ou bâtonnets plus ou moins longs disposés longitudinalement et obliquement." Ranson's description reveals that the "chalky" deposits do not consist of an amorphous mass of calcite; on the contrary "le calcaire est donc bien cristallisé au sein de ces lamelles."

CHEMICAL COMPOSITION AND SOME PHYSICAL PROPERTIES

We may wonder whether data on the chemical composition can give us any further insight into the true nature of the different layers of the oyster shell. Brandes and Bucholz (1817) estimated that the oyster shell consists of about 98.6% $CaCO_3$ and about 0.5% organic material. Chatin and Muntz (1895), analyzing likewise the entire shell found 86.5% to 95.9% $CaCO_3$, 0.71% to 0.99% $MgCO_3$, 1.3% to 1.7% $CaSO_4$ and 0.9% to 1.0% organic matter.

More interesting are the analyses of the separate layers taken from the oyster's shell. It was Schlossberger (1856) who procured such data:

Prismatic layer 89.1% $CaCO_3$ and 6.3% organic matter plus water.

Calcite-ostracum 94.7% to 98.2% $CaCO_3$ and 0.8% to 2.2% organic matter plus water.

"Chalky" deposits 88.5% $CaCO_3$ and 4.7% organic matter plus water.

There are but few more recent analyses available. Bull (1927) estimated that "chalky" deposits consist of 78.5% $CaCO_3$ and 19.2% water plus organic material, and Douvillé (1936) mentions for the prismatic layer, 88.4% $CaCO_3$ and 4.8% albuminoids.

That the "chalky" deposits contain quite a lot of NaCl has been recorded by Rose (1859) and can be deduced from von Nathusius-Königsborn's statement (1877) that a solution made with the powdered "chalky" layers stirred in water gives a thick precipitate with $AgNO_3$.

Our knowledge of the structure of the "chalky" deposits, demonstrating its multitude of closed cavities filled with sea water, leads to the conclusion that there must be inevitably some sea salts inclosed in these layers.

The scantiness of data led me to collect pure samples of the different layers of the oyster shell (excluding the extremely thin periostracum) and to ask Dr. A. Grijns of the Bergen-op-Zoom Fisheries Laboratory to make an analysis of them, to which request he kindly acceded. After a thorough drying, a sample was weighed and dissolved in hydrochloric acid; next the calcium was precipitated as oxalate and estimated in the form of CaO (Treadwell, 1923, Vol. II, pp. 61-62). The percentage of nitrogen was estimated by the Kjeldahl method (modification Gunning Atterberg), from which figure the conchyolin content was calculated by multiplying with 6.9, since Schlossberger demonstrated that conchyolin from oyster shells contains 16.7% N. Another sample was extracted with water; in the solution thus obtained, chloride was titrated in the usual way and from that figure the quantity of sea salts has been computed. As I was especially interested in the relation between $CaCO_3$, conchyolin, and sea salts, I did not bother about the possible presence of some minor constituents. In a second set of samples, collected a year later, conchyolin only was checked to investigate whether the figures obtained in analyzing the first set were really representative in this respect. The results of these analyses are tabluated below:

	Prismatic-layer	*Calcite-ostracum*	*"Chalky" deposits*
$CaCO_3$	94.7%	98.5%	90.9%
Conchyolin	3.4%	0.6%	1.1%
Sea-salts	0.1%	0.1%	6.5%
Not recognized (silt, sand, etc.)	1.8%	0.8%	1.5%
	100.0%	100.0%	100.0%
Special conchyolin estimation in second set of samples	4.5%	0.5%	0.8%

Though not exactly the same, these figures correspond very well with the old data contributed by Schlossberger and with those of Douvillé. Those of Bull cannot be compared because we do not know the relation between water and organic matter in his samples.

What can we deduce from our figures? In the first place, we see that the prismatic layer—the scales of the flat valve—although apparently constructed of "horny" material is composed in reality of a very high percentage of $CaCO_3$ and only about 4% of organic matter. Knowing this, it surprises us that the scales of this layer are in practice so elastic that they have an important share in the oyster's impervious closure.

In the second place, parts of the calcite-ostracum free from "chalky" enclosures are composed of a very high percentage of $CaCO_3$ and only 0.5% to 0.6% of conchyolin.

In the third place, the "chalky" deposits, by some earlier investigators thought free of organic matter, contain more of it than the normal calcite-ostracum does. Since we now know more about its minute structure and since Ranson showed that its elements after decalcification show a dry residue of about 1.6%, it does not surprise us to find quite an amount of conchyolin in these deposits. At first sight it seems very odd that the "chalky" deposits contain the smallest percentage of calcium carbonate of all the layers of oyster shells, the "horny" prism-layer included. It would have surprised Gray to hear that, for he thought the "chalky" deposits to be virtually pure $CaCO_3$, without organic elements, and therefore did not want to reckon them among the "proper structure of the shell." We see, however, that it is the admixture with a considerable quantity of sea salts, which is the cause of the lower $CaCO_3$ content. Sea water is enclosed in the multitude of small cavities in the "chalky" deposits, and therefore we find it in our dried samples as salts. If we consider the "true" shell material, there is little difference in chemical composition of calcite-ostracum and its embedded "chalky" deposits, the latter showing a somewhat higher percentage of conchyolin.

As to some physical properties, we find in the literature the data of Bütschli (1908) who states that the specific gravity of the prismatic layers is 2.6 and of the calcite-ostracum 2.7. He worked with powdered shells, so was not aware of the porous nature of the "chalky" deposits. Ranson (1941, 1943) actually saw their porous nature, but only mentions that these layers contain a good deal of water.

I checked the specific gravity of intact parts of shell (after drying) and came to 2.5 for the calcite-ostracum (devoid of "chalky" material) and to only 0.5 for the "chalky" deposits. This indeed is a great difference! As some 6% of sea salts are imbedded in this air-dry material, the figure 0.5 is still too high if one wants to consider the quantity of calcite necessary for the construction of a given volume of shell material.

THE MECHANISM OF THE DEPOSITION OF "CHALKY" LAYERS IN THE OYSTER SHELL

Some authors claim that they can advance a plausible explanation of the fact that the oyster deposits "chalky" layers in certain places in its shell and not in others. Pelseneer (1920) expresses himself quite cautiously in advocating a possible secondary solution of lime: ''Ainsi, chez Ostrea, la couche moyenne est la moins riche; puis vient l'externe et enfin l'interne, de sorte, que tout se passe comme il s'était produit, apres le depot de calcaire un phenomène de redissolution et de réabosorption pour la sécrétion de la couche interne.''

Anyone who has examined oyster shells during the growth season knows that ''chalky'' layers are deposited in a porous state and that they are covered with harder layers only later. Their porous structure cannot be attributed to a secondary solution of lime.

Orton and Amirthalingam (1927) suggest more positively that ''chalky'' deposits can be expected as soon as the oyster's mantle epithelium loses contact with the shell. It is assumed that the oyster secretes ''chalky'' material in order to restore the contact as quickly as possible. The most important layers of ''chalky'' deposits are to be found opposite the oyster's exhalent chamber, just beyond the scar of the adductor muscle, and this especially in the cupped valve. Orton states that the oysters usually are to be found on the beds with the cupped valve uppermost, and that in this position the epithelial ceiling of the exhalent chamber —not supported by visceral tissues—is inclined to sag, so that the contact between mantle and shell is lost here. Hence the secretion of ''chalky'' deposits especially in this particular part of the oyster's cupped valve.

Ranson (1939-1941) follows Orton in this reasoning without hesitation: ''il s'agit tout simplement de décollements locaux du manteau, résultant de la présence de sillons ou autres cavités variées que le manteau ne peut poursuivre, par suit d'une modification des conditions de sécrétion de la bordure de la coquille.''

I could not believe in this theory. It is a fact that ''chalky'' deposits are far more numerous opposite the exhalent chamber in the cupped valve than in the flat valve, in any case in oysters of about three to five years old. I doubted, however, whether this could be explained by the oysters lying flat valve undermost and by a subsequent sagging of the exhalent chamber's ceiling. I often examined oysters lying on the beds in the Oosterschelde (Holland). Oysters which are strewn on the beds from a moving boat—which is the usual procedure here—will reach the bottom with the cupped valve undermost, owing to their shape and the laws of friction. On a relatively soft bottom they will seldom be overturned afterward; on a hard and smooth bottom, on the contrary, strong currents can easily overturn oysters lying on the cupped valve, whereas oysters lying with the flat valve undermost are not easily affected by the current. Intermediate cases are found on bottoms of intermediate firmness. In such places I counted in fact about 50% of the oysters lying with the cupped valve undermost and about 50% lying on the flat valve (observations at extremely low water). Yet all our oysters show the bulk of "chalky" deposits in the cupped valve.

A simple experiment confirmed these field observations. In the spring of 1942 I placed about 25 medium sized oysters on a tray, cupped valve undermost, and covered them with another tray in such a way that the oysters could not be overturned. Repeated controls showed that the oysters remained lying cupped valve undermost. In a similar tray I placed about 25 oysters with the flat valve undermost. All these oysters showed excellent growth and have been analyzed late in 1942. Some of them showed "chalky" deposits recently produced beyond the muscle scar. Early in 1942 none of these oysters showed "chalky" deposits opposite the exhalent chamber as analysis of a control sample demonstrated.

Analysis of experimental oysters, November 1942:

25 oysters, cupped valve undermost during the growth season of 1942

24%	no "chalky" deposits	opposite the exhalent chamber in the cupped valve
44%	moderate quantities	
32%	much "chalk"	

23 oysters, flat valve undermost during the growth season of 1942

39%	no "chalky" deposits	opposite the exhalent chamber in the cupped valve
26%	moderate quantities	
35%	much "chalk"	

In my opinion the differences observed between the two series are quite insignificant. In each group I found only one oyster with "chalky" deposits in the flat valve opposite the exhalent chamber. We cannot understand how "chalky" layers are deposited in oysters lying cupped valve undermost if the "sagging of the ceiling theory" is assumed to hold good, and we cannot understand why these very same oysters do not produce "chalky" deposits in the flat valve as the topmost mantle epithelium of the exhalent chamber is certainly as liable to sagging in these oysters as it is supposed to be in oysters lying flat valve undermost. In fact my experimental oysters lying cupped valve undermost show even rather more "chalky" material than those of the other group. This leads me to reject the hypothesis of Orton and Amirthalingam and with it Ranson's reasoning.

In considering the mechanism of the deposition of "chalky" layers in the oyster shell, I believe we ought to confine ourselves to stating that obviously every part of the shell-secreting mantle tissue possesses the faculty of constructing both the harder layers of the calcite-ostracum and "chalky" deposits. This is often carried out alternately. Until we know more about the biochemical events which guide shell-secretion, we find ourselves forced to leave undecided how the mantle epithelium succeeds in depositing "as locally required" either subnacreous or "chalky" layers. Which factor can be held responsible in determining what kind of material is "required" will be discussed in the next section of this paper.

First I would like to draw attention to Ranson (1940, 1943) who advanced still another factor in explaining the mechanisms of deposition of "chalky" layers. Only in places where the substrate is rich in calcareous material can one expect oyster shells with ample "chalky" deposits, according to him, while such layers should be absent in oysters living in areas poor in lime: "La pauvreté en calcium des fonds où croissent les huîtres semble être ici le facteur déterminant de l'absence des couches crayeuses." In his book (1943) he states: "Dans le bassin d'Arcachon, dont le fond de sable est pauvre en calcaire, Ostrea edulis et Gryphaea angulata ont une coquille très mince, presque translucide." This surprises me very much. The Dutch oyster farmers imported oysters *(Ostrea edulis)* from the Basin of Arcachon more than once, and in 1947 I visited this area myself, on which occasion I saw quite a lot of oysters. The shells of these oysters seemed thicker than anywhere else and possessed ample "chalky" deposits.

To explain why the shells of the Brittany oysters contain so much "chalky" deposit though the underlying bedrock here consists of acid granite, Ranson tells us that so many shells have grown there for so many generations that the bottom layers of the Morbihan bays gradually became quite rich in calcareous material. Ranson does not explain why this is not the case in the Oosterschelde and in the Basin of Arcachon, reckoned by him among the areas poor in lime.

In my opinion, Ranson's main mistake is that he seems to ignore that the quantity of calcium present in sea water is practically the same in the different parts of the Atlantic coast, viz., about 1 gram of $CaSO_4$ per liter. Unlike fresh water, the calcium content of sea water does not depend on the nature of the subsoil but on ionic balances and solubilities.

Fox and Coe (1943) have shown for the mussel *(Mytilus californianus)* that it is absurd to assume that the lime necessary for shell deposition is derived from the food ingested, and that we should suppose that mollusks take their lime either directly from the water or ingest it in particulate inorganic form. The particulate form being the debris of older shells we wonder how those gained their lime in earlier times in "acid" areas if the particulate form is the only one which can be used. I believe that mollusks, corals, and so on can take the calcium they need directly from the sea water where it is present in solution in large quantities. I believe that it does not matter, even if calcium is present in sea water largely as

$CaSO_4$. Experiments with hens (Irvine and Woodhead 1888-89) have shown that $CaSO_4$, $CaCl_2$, and other calcium compounds are as good a source of calcium in the formation of egg-shells as $CaCO_3$, if administered in the fowl's food. Further it is only arbitrarily concluded (from the sequence of events in evaporation) that the calcium is present in solution in sea water in the form of $CaSO_4$. Is it not better to express the calcium present as the number of calcium ions in sea water? Nobody can prove that it is not partly $CaCl_2$ mixed with Na_2SO_4 instead of $CaSO_4$ and NaCl. Living creatures possess the remarkable faculty of concentrating a variety of elements within their own bodies or shells against a concentration gradient. There is no reason to believe that oysters and other lime-secreting animals do not possess the power to "catch" in some still unknown biochemical way the calcium ions they need from the abundance in which they are permanently bathed.

The Possible Function of "Chalky" Deposits in the Oyster Shell

Though in the foregoing section I criticized certain opinions expressed by Orton and Ranson, I fully agree with other points in their papers. Orton and Amirthalingam (1927) state: "In very young oysters (1 to 2 years old) chalky deposits occur fairly frequently and irregularly, but obviously in places where a thick layer of shell material is required to fill up a space." Further: "It is submitted that the function of these deposits is to fill in rapidly depressions under the mantle or secreting epithelium, which depressions cannot be maintained in the physiological state of the oyster in that instant, or which can only be maintained with loss of its efficiency in functioning." And: "All chalky deposits of shell material are due, on the whole, to local unsuitabilities of the contours of the shell to the need of the oyster." Orton (1937) added that "chalky" deposits "are rapidly made to smooth out the inner contour of the shell. Such deposits are copious in regularly growing brood of *Ostrea edulis*, and particularly in the irregularly shaped brood grown on twigs in the Norwegian oyster polls."

Ranson (1939-1941) tells us: "couches crayeuses de peu d'importance remplissent des sillons du bord de la coquille," and further: "le resultant suggerait: l'animal avait besoin de remplir rapidement une cavité devenue inutile et qui le gêne," though I should add here, that Ranson himself shrinks from this reasoning and immediately resorts to the hypothesis of dislocation of mantle and shell to find an appropriate causal relation.

I entirely agree with the view that the oyster makes use of "chalky" deposits to smooth out the inner contours of its shell. Irregularly shaped oysters, e.g., those attached in crevices, growing on stones, or growing in clusters tightly together, succeed in creating a normal smooth shell interior by producing ample "chalky" deposits. Further, I have often observed that the extreme edges of the shells of young oysters growing well in a place not too exposed to the surf are inclined to take a somewhat undulating shape. As shell growth proceeds, the oyster always smooths out the inner contours of the shell by filling up all the little furrows with "chalky" material. This procedure certainly is very economical. For from my estimation of the specific gravity mentioned above, it follows that the oyster thus can fill up a space with less than one-fifth of the shell material (both organic and inorganic) that would be required if the normal harder layers were to be deposited. With good reason we can state that the oyster uses these "chalky" deposits as a "cheap padding."

The fact remains, however, that in oysters of three years and older, by far the most important "chalky" deposits are to be found opposite the exhalent chamber, just beyond the muscle scar, in a place where we cannot detect a space which requires filling in to smooth out the shell's interior contours. The older the oyster, the more successive layers of "chalky" material appear to be deposited there.

This fact has been recognized by virtually all the workers in this field. Gray (1838) has already recorded that those layers are found "commonly forming a convex spot in the cavity of the oyster, just beyond the scar of the central adductor muscle." Others corroborate this finding. When we follow the events in a growing oyster, we see that deposition of "chalky" layers beyond the muscle scar begins at an age of about three years, and then in the cupped valve only. In due time the deposited porous layer is covered by harder layers of the normal subnacreaus type. Later the entire shell puts on a new rim of growth, the muscle moves away from the hinge—as it has been doing ever since the oyster started growing—and a new layer of chalky material is deposited beyond the muscle scar opposite the exhalent chamber. In due time a harder subnacreous layer is found to cover this second porous layer, too. This goes on as depicted in figure 1. Every succeeding "chalky" layer is placed somewhat farther away from the hinge than its predecessor owing to the steady displacement of the muscle. Beginning with the oyster's fifth or sixth year, "chalky" layers are deposited not only in the cupped valve but also in the flat valve, here too, opposite the exhalent chamber. The older the oyster, the more deposits we find till at last in some very old and thick oysters, it is difficult to tell at first sight which is the cupped and which the flat valve. The oysters depicted in Petersen's paper (1918), though not accompanied by an explanation of this kind, can assist us likewise in following events during the oyster's development. Tullberg (1881), however, was led astray and depicted in his paper a section of an old oyster in which there is no difference whatever between cupped and flat valve. A closer observation reveals that he depicted two cupped valves connected together, which is not correct. A photograph is more trustworthy in this field, and the very old oyster, shown in figure 2*, clearly shows the actual relations and the permanent difference between cupped and flat valve. The older parts of the shell demonstrate especially clearly that the deposition of "chalky" layers is far more important in the cupped valve even when the "flat" valve is inclined to take a "cupped" shape as can be observed in some, but not in all, old oysters (cf. figure 1). Moreover, only the flat valve possesses a scaly prismatic layer, as has been discussed above, but this layer may be easily lost on dry specimens.

What is behind this rhythmic deposition of "chalky" layers in this particular part of the oyster's shell where we see no obvious need to fill in an inconvenient space?

Southern (1918), who stated "at the approach of the succeeding spawning season the gonadal cavity is again enlarged by the rapid deposition of soft shell substance in that part of the shell which surrounds the gonadal cavity," was obviously wrong, as only the addition of a new rim to the entire shell can enlarge its cavity; the more the angle of this rim deviates from the horizontal, the deeper the shell becomes.

Bjerkan (1918) believed, from studying the oyster depicted in figure 2, that the thin dark layers seen between the "chalky" deposits, considered by him to be layers of conchyolin, are produced in summer, whereas the thick "chalky" deposits are laid down in the winter season: "De tynde konchyolinlamellar som gaar fra laasen og ut mot skallets rand avsættes om sommeren, en ny lammelle for hver sommer. Særlig om vinteren avsættes der imidlertid kulsur kalk mellem lamellerne." Bjerkan believed that counting the number of "chalky" layers in sections of oyster shells is a very reliable method of determinnig the oyster's age. Even if we assume with Bjerkan that one "chalky" layer is produced each year (and never two or none, which remains to be demonstrated), we should remember that deposition of "chalky" layers beyond the muscle scar only starts at an age of 3 to 4 years, and not at the same age in different oysters and in different oyster districts. It certainly is not a weathering off of older shell-parts which is responsible for the distance between the hinge and the place where "chalky" deposits begin, as Bjerkan believed: "Den store avstand mellem skjællets laas og den første lamelle lar imidlertid til at antyde at et ældre parti av skallet er forvitret." This phenomenon is no doubt due to the advanced age at which the deposition of these layers begins. If we cannot agree with Bjerkan's explanation of this de-

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* I am indebted to Dr. P. Bjerkan, Bergen, Norway, who kindly sent me a copy of this photograph, upon my request.

tail, we must admit that his method is still the best to esitmate the age of an old oyster. Also that it is quite reliable if oysters from one and the same region are considered and if oysters of an accurately known age which are grown in the same region are available for comparison in order to check the age at which deposition of "chalky" layers starts.

Douvillé (1936) believed that soft material is deposited in the months without an "R" and harder layers in those with an "R" (just the oppo-

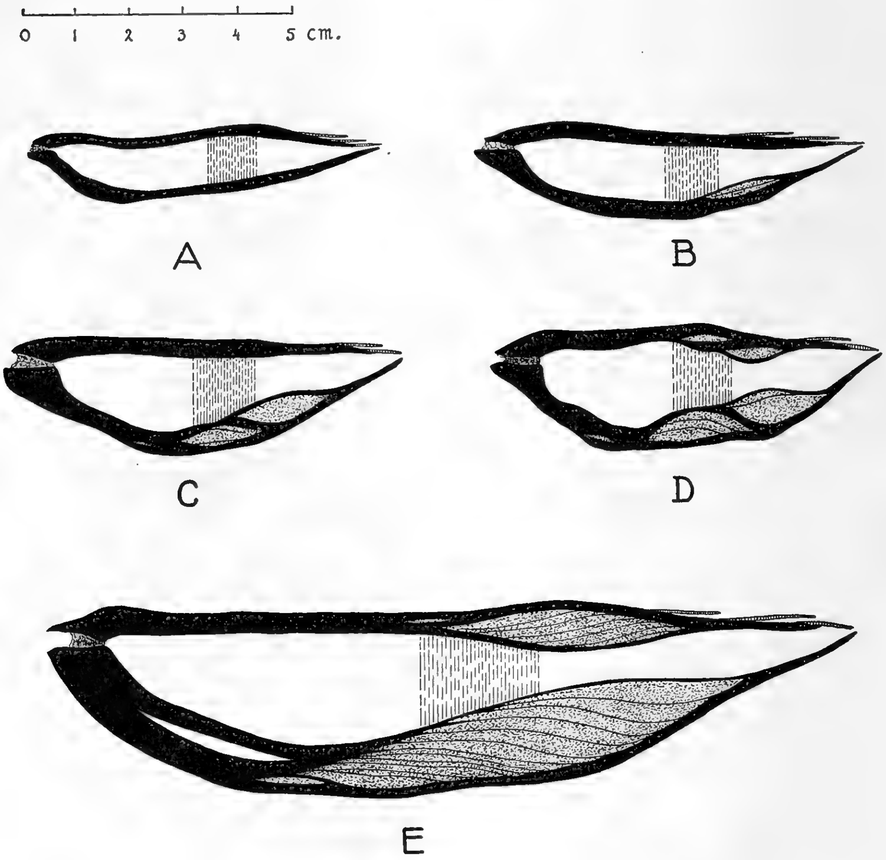

Figure 1. Cross-sections of oyster shells. Place and size of the adductor muscle is indicated. Filled in black: hard sub-nacreous layers. Hatched: prismatic layer. Dotted: "Chalky" deposits. Note the increasing depth of the part of the shell lodging the "body" of the oyster, while the distance between the valves is maintained at a constant level opposite the exhalent chamber (beyond the muscle). A, B, two Dutch native oysters. C, a relaid Brittany oyster. D, a relaid Arcachon oyster. E, a very old oyster from a natural bed in the North Sea, showing a chamber in the cupped valve.

site of what Bjerkan claimed). There is something in this view, as one finds the porous layer at the surface, newly deposited, during the period in which rapid growth occurs (which is the summer season here). By contrast, there is a covering of harder layers produced during the periods in which the oysters thicken their shells. These periods occur here during spring and autumn. Douvillé cannot explain, however, why the layers are deposited only in this particular place, and why not all over the shell's interior.

Orton's hypothesis of the sagging of the exhalent chamber's roof has already been discussed and rejected. Basing my argument on another part of Orton's reasoning I offer the following explanation:

In discussing the filling up of depressions, Orton states that these "cannot be maintained in the physiological state of the oyster in that instant or which can only be maintained with loss of its efficiency in functioning."

I presume that the oyster deposits "chalky" layers opposite the exhalent chamber, when growing older, *in its efforts to maintain its "efficiency in functioning."* That "chalky" material instead of harder layers is used indicates only the oyster's "economy"; *where possible the oyster always uses soft porous deposits when quite a lot of shell volume has to be produced, since this requires only one-fifth of the material which the deposition of harder layers demands.*

What is the result of the deposition of "chalky" layers beyond the muscle scar, in the cupped valve first, in both of the valves in older oysters? The result is that *the distance between cupped and flat valve always remains limited in this area, no matter how large and deep the part of the shells lodging the visceral and reproductive tissues of the oyster may become.* In oysters of three to four years and older which I investigated, this particular distance never differed much from 0.5 to 0.6 cm. This is clearly demonstrated by the oysters of figure 1, drawn accurately in natural proportions. The figure 0.5 to 0.6 cm. holds good for the degree of closure depicted. During violent contractions of the adductor muscle it will be somewhat lower; during feeding, on the other hand, while the shells are held slightly ajar, it will be somewhat higher.

I feel sure the oyster requires for its efficiency in functioning (perhaps in producing its regular flow of water, bringing food and oxygen) a very moderate height of the exhalent chamber. If the distance between the two valves is least opposite the exhalent chamber, there is only a slightly greater distance between the valves opposite the gills. The more the oyster is cupped, the more the size of the subsequent "chalky" deposits expands in a horizontal direction. In old oysters the "chalky" deposits laid down at regular intervals extend over a considerable part of the shell, opposite exhalent and inhalent chamber, but never under the oyster's visceral parts (i.e., under the true

Figure 2. Cross-section of a very old oyster, originating from the Norwegian coast. Bjerkan estimates its age at approximately 26 years. Note the convex shape of the "flat" valve, compared with that shown in figure 1, E. Chambers in both of the valves. The hypostracum, marking the course the muscle scar has taken, clearly visible.—Photo, Lea.

"body" of the oyster). What evidence can be adduced to corroborate my view?

In the first place, the figures in the paper of Petersen (1918) and in the booklet of Gaarder and Bjerkan (1934) and also the photograph depicting the large oyster (fig. 2) which has already been published by Bjerkan (1918), all show very clearly how shallow the region of the exhalent chamber remains even in old and deep oysters, which agrees with my oysters depicted in figure 1.

In the second place may be cited the results of a closer examination of oyster shells originating from different localities. If my theory is correct we can expect thicker or thinner layers of "chalky" material, according as the shells are more or less cupped in shape irrespective of the place where the oysters are grown.

To this end I compared the shells of the marketable oysters in my collections. These shells, all of a diameter of approximately 7 cm., were taken at random from groups of oysters four to five years old. I computed an index for the degree to which the oysters are "cupped" in the following way, using the cupped valve only, as the flat valve is still very flat at this age:

$$\frac{\text{height}}{\text{mean diameter}} \times 100$$

I used as mean diameter the average of the greatest dimensions of the shell in two directions (parallel to the hinge and at right angles to it). To check the height I laid the cupped valve flat on the table and measured how much the highest part of the shell reached above the surface of the table. I am aware that for this purpose it would have been more accurate perhaps to measure the shell's interior, using a kind of conchograph like that devised by Vlès (1904), but my method required no intricate apparatus and gave quite a good idea of the "cuppedness" of the shells which were of a regular shape. The presence of "chalky" deposits beyond the muscle scar was estimated approximately by separating them into categories: "absent," "little," "moderate," "much," and "very much." The results of this investigation are tabulated below:

1. Dutch oysters, spat settled on tile-collectors; during second year grown in wire-covered trays. Excellent growth. Analyzed in their second winter. Mean diameter 6 cm.; 48 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	15	20.0
Little	10	22.0
Moderate	23	25.0
Much	0	—
Very much	0	—

2. Dutch oysters, spat settled on tile-collectors; grown on wire-covered trays in both 2nd and 3rd summer. Analysis 3rd winter. Mean diameter 7 cm.; 48 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	6	18.2
Little	9	21.3
Moderate	20	22.5
Much	13	23.2
Very much	0	—

3. Dutch oysters, spat settled on tile-collectors. After detachment, at 9 months, scattered on a deeper oyster bed (peat soil), and grown there during their 2nd, 3rd, and 4th summer. Analysis 4th winter. Mean diameter 7 cm.; 48 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	6	20.5
Little	12	22.8
Moderate	16	24.1
Much	13	27.0
Very much	1	30.0

4. Dutch oysters, spat settled on shell-collectors; grown on deeper parcels since. About 4 years old. Mean diameter 7 cm.; 35 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	4	21.8
Little	10	22.5
Moderate	13	24.4
Much	7	28.6
Very much	1	32.0

5. Brittany oysters, imported spring 1937, relaid in Dutch waters for one summer season. Analysis November, 1937. Mean diameter 7 cm.; 82 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	2	19.5
Little	14	22.7
Moderate	34	24.6
Much	27	27.3
Very much	5	28.2

6. Arcachon oysters, imported spring 1937; relaid in Dutch waters for one summer season only. Mean diameter 7 cm.; 51 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	1	23
Little	2	23
Moderate	21	26
Much	15	27
Very much	12	32

7. Brittany oysters, directly imported as full grown marketable oysters. Mean diameter 7 cm.; 36 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	0	—
Little	5	20.8
Moderate	10	24.2
Much	13	26.0
Very much	8	29.0

8. Arcachon oysters, imported as full grown marketable oysters. Mean diameter 7 cm.; 13 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	0	—
Little	0	—
Moderate	1	27
Much	4	28.5
Very much	8	30.2

9. French oysters from a natural oyster bed, Finistère. Mean diameter about 7 cm.; 23 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	0	—
Little	1	19
Moderate	5	25
Much	8	27.6
Very much	9	32.0

10. Italian oysters, imported as full grown marketable oysters. Mean diameter about 7 cm.; 9 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	0	—
Little	0	—
Moderate	1	26
Much	1	31
Very much	7	29

11. Norwegian oysters, imported spring 1937; grown in Dutch waters for one summer season. Mean diameter about 7 cm.; 12 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	2	21.5
Little	2	24.5
Moderate	5	25.8
Much	2	25.5
Very much	1	28.0

12. English oysters from the Truro beds, not yet ripe for the market. These oysters diverge somewhat from the round shape and approach a triangular shape. Mean diameter 6 cm.; 22 specimens.

"Chalky" deposits	*Number*	*Index*
Absent	3	23.3
Little	6	25.2
Moderate	10	25.6
Much	3	27.4
Very much	0	—

These figures clearly show that the presence of copious "chalky" deposits in the cupped valve of oysters of normal marketable dimensions (about 7 cm.) is not confined to oysters grown on beds characterized by a high percentage of calcareous material as Ranson suggested. Oysters showing "chalky" deposits beyond the muscle scar may be found among samples from practically any provenance irrespective of the culture method used.

Further, these figures indicate that there is a close correspondence between the quantity of "chalky" material deposited beyond the muscle scar and the degree to which the shell is cupped. I am aware that there exist individual variations, but if one works with not too limited numbers there is a marked correlation between the two figures. The deeper the shells are, the more "chalky" material we can expect to find. The shells ranked among those showing very much "chalky" material possess as a rule such deposits in the flat valve also.

Oysters of different provenance often differ in the percentage of shells showing copious "chalky" deposits. Our oyster farmers are correct when they say that relaid French oysters show more "chalk" in the shell than do native Dutch oysters. This corresponds with a greater degree of "cuppedness" of the French oysters. Oysters from Arcachon possess very deep shells and proportionally profuse "chalky" deposits beyond the muscle scar. If we compare Dutch oysters with French oysters and relaid French oysters, we find that the different categories of "chalky" deposits, distinguished as in the tabulation above, are to be found at nearly the same value for the index of cuppedness:

"Chalky" deposits	*Index (Dutch)*	*Index (French)*	*Index (relaid French)*
Absent	21.2	—	21.2
Little	22.7	20.8	22.8
Moderate	24.2	24.2	25.3
Much	27.8	27.2	27.2
Very much	31	29.6	30.1

The presence of calcareous material in the bottom deposits apparently has nothing to do with the formation of "chalky" deposits. Still there exists some kind of influence of environmental factors. Both hereditary qualities and environmental conditions (in the latter probably mainly the physical, possibly also the chemical and biological characteristics of the substrata on which the oysters are grown, and also the effect of currents and surf) determine whether the oysters are predominantly inclined to grow a cupped or a relatively flat type of shell, and with that the quantity of "chalky" deposits to be laid down in the shell.

In the third place, I tried to determine the significance of the narrow shell cavity beyond the muscle scar and to find out what happens when the "chalky" layers there are taken away. I anaesthetized some oysters and carefully took away a great deal of the "chalky" deposits, then placed them back on a tray. Though oysters can easily stand anaesthetization (with the aid of $MgSO_4$), the oysters bereft of their "chalky" deposits died, all of them within two months. Probably I treated them too roughly. I cannot tell what was the exact cause of death. Could it be that nutrition or respiration was impaired by interfering with the correct functioning of the gill-apparatus? Further investigations in this field, carried out with more delicate methods than I used, are required to find the answer to this question.

Formation of Chambers

I do not want to conclude this treatise dealing with features of the oyster shell without mentioning the phenomenon of "chambering." In many oyster shells we can detect shallow cavities, filled with sea water (often putrefied through anaerobic conditions), occurring predominantly in the cupped valve under the visceral parts of the oyster. Sometimes we find only one "chamber," sometimes an entire series of them. When the walls of these chambers are thin and easily broken by the knife in opening the oysters (which sets free the often evil-smelling contents of the chamber), the Dutch oyster farmers characteristically speak of "cat-ice" oysters. Such oysters are but rarely found in the Oosterschelde, the Dutch oyster center, although fairly often in several of the French oyster districts. Very old oysters almost always show a series of chambers in the cupped valve, in very old specimens even in the flat valve.

These chambers have been noticed by several investigators. Houlbert and Galaine (1916) discuss the occurrence of chambers in the oyster shell and state: "les couches de nacre successives ne sont point au contact, elles se sont formées à une petite distance les unes des autres, comme si l'animal, diminuant d'épaisseur, et habitant, par suite, une maison trop grande, avait voulu ramener sa demeure à ses propres dimensions."

Orton (1937) expresses the same view: "chambering appears to be due entirely to shrinkage of the body with subsequent automatic secretion of nacreous material by the surface of the shrunken body, destined normally for thickening the shell.'' Orton adds that a rapid rise in salinity brings about considerable shrinkage of the oyster's body and he holds this fact responsible for the formation of chambers in the oyster shells, together with the effect of ample spawning, which view had been expressed earlier by Orton and Worsnop (1923).

I entirely agree with these views. ''Chambrage'' is to be expected in oysters exposed to salinity changes so characteristic of many of the French oyster regions. In the Oosterschelde, where the salinity is remarkably equable, chambering seldom or never occurs in oysters three to five years old. Salinity changes are not the only factor to be held responsible for ''chambrage,'' since very old oysters living in the North Sea beyond the reach of marked salinity changes invariably show chambering of the shell. Possibly shrinkage owing to spawning is the cause of this phenomenon. In younger oysters spawning does not bring about chambering, in any case not in the rich Dutch waters where the oysters rapidly make up losses due to spawning. That the oyster *(Ostrea edulis)* is not able to counteract quickly the influence of a changing salinity is demonstrated by oysters which are suddenly exposed to reduced salinities. The living tissues soon look puffed up, a fact which is sometimes made use of by unscrupulous oyster dealers, in their efforts to sell lean oysters.

It is noteworthy that typical museum biologists once held different views concerning the chambers. Gray (1833) said, in dealing with oysters displaying a series of chambers, that there was no siphon passing from one septum to the other, thus indicating that it reminded him of the shell of *Nautilus* with its many chambers connected by a siphon passing through the septa.

Laurent (1839, 1839a, 1844) thought that he detected the siphon and really suggested that some kind of family relation might exist between *Nautilus* and *Ostrea!* What he thought to be a siphon, comparable to that of *Nautilus,* was the rudiment of the retractor pedis muscle, which connects the shell with the mantle tissues just opposite the labial palps. This muscle is seldom mentioned in the oyster literature. Elsey (1935) records its presence in *Ostrea lurida* and *Ostrea gigas.* I can state that this reduced foot retractor muscle is not of much importance to the oyster. In a number of oysters I cut these muscles on both sides, after anaesthetization. These oysters thrived normally afterward, not showing any signs of distress. Leenhardt (1924) assumes that they may play a part in keeping the animal in its proper place within the shell. This may be true, for some of my experimental oysters showed a partly doubled ligament, demonstrating a slight displacement of the epithelium which is responsible for the secretion of new layers of ligament.

It is now generally accepted that chambering is caused by shrinking of the oyster's tissues, which shrinkage is important where the meat of the oyster is thickest, i.e., in the true "body" of the oyster. Subsequently, deposition of shell layers, preceded by a thin sheet of conchyolin, takes place to adjust the size of the shell cavity to the size of the body. We, therefore, always find the chambers opposite the visceral parts of the oysters. Here is a true case of dislocation between shell and mantle. This apparently always results in the formation of a water-filled chamber and never in the deposition of "chalky" deposits as Orton and Ranson supposed.

It is easy to prove this experimentally. If an angular object is fixed in the shell's interior so that the mantle cannot easily reach the chinks, and if such oysters are kept under natural conditions, we will observe sooner or later that the object and its immediate surroundings are first covered with a sheet of conchyolin on which harder subnacreous layers are deposited in due time. Small chambers are thus created around the foreign object.

SUMMARY

"Chalky" deposits in oyster shells consist of the same material as the harder subnacreous layers. They differ in that the opaque "chalky" deposits are of a highly porous structure, whereas subnacreous material is more solidly built. In depositing a given volume of "chalky" material the oyster needs only one-fifth of the shell-substance (both organic and inorganic) it would need if constructing it of subnacreous material. "Chalky" material is used by the oyster as a measure of economy, as a "cheap padding" in smoothing out the shell's interior and in creating the right shell shape to maintain its efficiency of function. This means that the oyster always keeps the distance between the two valves very limited where the exhalent chamber is located. In a lesser degree this also is true of the inhalent chamber. The more the oyster shell attains a cupped shape, the more layers of "chalky" material are deposited beyond the muscle to maintain the proper shell dimensions, which are apparently necessary for its well being.

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RELATIONSHIPS OF THE PELAGIC SHARK EUPROTOMICRUS BISPINATUS, WITH DESCRIPTION OF A SPECIMEN FROM OFF CALIFORNIA*

BY

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On the night of November 19, 1948, while fishing with a dip-net under a surface light at 34° 57′ N. Lat., 131° 30′ W. Long. (nearly 500 nautical miles off the nearest point of the California coast), in a region where the ocean depths are indicated as ranging between 2,400 and 2,800 fathoms, the junior author and Robert P. Huffer captured a pelagic shark (plates 4–6) that was cruising slowly at the surface. Its small size, slender and cylindrical form, subconic head, round and unprotected eyes, scarcely upturned caudal axis, smooth contours, very slimy skin, almost uniformly blackish color, except on the clear outer parts of the fins, and its very small gill slits gave it an appearance that was distinctly unlike that of most sharks and that was somewhat suggestive, superficially of course, of a lamprey.

We owe thanks to Dr. Léon Bertin of the Muséum d'Histoire Naturelle, Paris, for measurements of the type specimen of *Scymnus bispinatus* Quoy and Gaimard, and to William C. Schroeder of the Museum of Comparative Zoology of Harvard University and W. I. Follett of the California Academy of Sciences for assistance in processing literature.

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IDENTIFICATION OF SPECIMEN AND STATUS OF THE GENERA EUPROTOMICRUS AND SQUALIOLUS

On study the specimen (California Academy of Sciences, No. 20431), a female 233 mm. in total length, is identified with *Euprotomicrus* Gill, a squaloid genus referable to the family Dalatiidae (Scymnorhinidae) as currently recognized. It is clearly conspecific with the hitherto unique type of *E. hyalinus* Eigenmann (1893 : 35), which was also collected in the open Pacific between Hawaii and California, but nearer Hawaii. That specimen was destroyed in the San Francisco fire. The one at hand is the only extant example of the genus known from the Pacific Ocean and, so far as we know, the only one in an American museum.

It seems highly probable that *E. hyalinus* is identical with *E. bispinatus* (Quoy and Gaimard). Garman (1913 : 235) doubted its distinction and Fowler (1941 : 265) synonymized it with that species. The obviously pelagic habitat of *E. bispinatus* and the wide temperature difference between its known areas of occurrence suggest that it is a widely ranging species. In addition to the two known localities in the northeastern Pacific, the record stations for *E. bispinatus* comprise the islands of Mauritius (Île de France) and Bourbon (Réunion) in the Indian Ocean and Campbell Island, far south of New Zealand (see synonymy by Fowler). The New Zealand record (references in Phillipps, 1927 : 10) seems to have been in error, according to evidence later presented by Phillipps (1928 : 224–225).

The new specimen does differ in certain respects from the only generally available recent description of *E. bispinatus,* namely Fowler's. Though this author attributed his redescription to Quoy and Gaimard (1824 : 197, pl. 44, figs. 1–2), an examination of the original description shows that Fowler must have based his account, including measurements, largely on the rather crude figure (which was reproduced in outline by Phillipps, 1928, fig. 5), and must have used methods of measurement different from those we adopt.

Fowler's indication that the pectoral extends half way to the first dorsal in the type was obviously drawn from the main figure, which must be in error. That this fin in the type as well as in our specimen extends less than one-third the distance to the origin of the first dorsal is indicated by the size of the fin shown in the ventral view in the type figure, by measurement of a topotype given by Müller and Henle (1841 : 95) and, conclusively, by remeasurements of the holotype made for us by an assistant to Dr. Léon Bertin in accordance with our specifications.

Confusion was also encountered in regard to the position of the first dorsal fin, but again the full evidence fails to confirm suggestions of a specific difference. In his purported restatement of the original description, Fowler wrote "first dorsal inserted midway between snout tip and caudal base'' (which would indicate an approach toward *Squaliolus)*, but the figure shows the position midway between snout tip and the end of the caudal fin. Our specimen has the fin inserted even farther back, midway between the tip of the caudal and the middle of the eye. Duméril (1865 : 457), who had three specimens, indicated the dorsal origin as ''située un peu en arrière de la première moitié de la longueur totale.'' Fortunately, the type is extant. Dr. Bertin's measurements (p. 170) indicate that the origin of the dorsal in the type is essentially as in our specimen. He has also compared a copy of our figures with the holotype of *E. bispinatus*, and concurs in the view that *E. hyalinus* is probably a synonym of *E. bispinatus*. Accepting this view, we treat *Euprotomicrus*, like most related genera, as monotypic.

Garman (1913 : 234), Bigelow and Schroeder (1948 : 500), and Fowler (1941 : 264) synonymized *Squaliolus* with *Euprotomicrus*, but in our opinion the generic separation is fully justified, even in a conservative concept of the genus. *Euprotomicrus* differs from *Squaliolus*, as described by Smith and Radcliffe *(in* Smith, 1912 : 683–685, fig. 4, pls. 50 and 54), in the following respects:

(1) The total lack of the first dorsal spine. To forestall any thought that the name *bispinatus* suggests dorsal spines in the type species of *Euprotomicrus*, we point out that this name obviously was derived from the spiny process on each pelvic fin of the male holotype.

(2) The more posterior origin of the first dorsal fin, which is much nearer the insertion of the pelvic than that of the pectoral fin, rather than the reverse, and is well behind instead of well before the middle of the total length.

(3) The more reduced size of the first dorsal fin. The base of this fin is less than one-thirtieth, instead of more than one-twentieth, the total length.

(4) The less excessively elongated second dorsal base, which is less than one-fourth, instead of nearly one-half, the interspace between the origins of the paired fins. The dorsal base does not overlap the pelvic base, as it does in *Squaliolus.*

(5) The rounded rather than pointed caudal lobes.

(6) The thickly rounded rather than pointed snout, in both side and top views.

(7) The smaller head. The head length is about one-fifth rather than one-third the total length.

(8) The longer mouth grooves, in lateral projection about two-thirds rather than one-third the preoral length.

(9) Probably also in dentition: the upper teeth are arranged more in quincunx than in the straight rows that were figured for *Squaliolus* and the lower teeth have the crowns in full contact basally, instead of being separated by the outer shoulders of the bases, as figured. Each of these

shoulders, in consequence, lies wholly on the base of the next outer tooth.

A third species, *Squaliolus sarmenti* de Noronha (1926), from Madeira, has been referred to *Euprotomicrus* (Maul, 1949 : 139), but obviously should be retained in *Squaliolus.* In fact, there seems to be no valid ground for separating *S. sarmenti* from the Philippine species *S. laticaudus.* The first dorsal fin was indicated as being somewhat more posterior, but on comparing the photographs and considering the distortion of the preserved specimens, we fail to appreciate the distinction. Consequently, we synonymize *S. sarmenti* with *S. laticaudus* and thus reduce *Squaliolus,* as well as *Euprotomicrus,* to monotypic status.

That *Euprotomicrus* and *Squaliolus* should be treated as monotypic, along with most of the related genera as currently recognized, need not cause concern to a conservative systematist. When species differ so trenchantly from one another, their degree of differentiation is better expressed by full generic separation than by forcing them into larger genera.

RELATIONSHIPS OF EUPROTOMICRUS

Euprotomicrus differs rather sharply from the other genera currently assigned to the Dalatiidae (Bigelow and Schroeder, 1948 : 500). It contrasts with *Isistius* in having no subterminal notch in the caudal fin *(Isistius* has a shallow notch at the end of the body axis) ; the bases of the first dorsal and pelvic fins well separated vertically; the second dorsal basally elongated; the lower teeth strongly oblique instead of erect, with a deep incision on the outer edge and a broad shoulder wholly overlapping the next tooth outward; the dermal denticles more scattered and with roots extending out from the four corners. From *Dalatias* it differs in having the caudal axis much abbreviated and straight rather than upturned; the subterminal caudal notch obsolete, instead of well developed; the first dorsal fin behind instead of before the middle of the total length; the second dorsal fin with a much elongated base, not overlapping that of the pelvic fin; the lower teeth smooth-edged and strongly oblique; the dermal denticles quadrate and hollow-centered, without a posterior spine and without lengthwise ridges. From *Heteroscymnus (longus),* as described by Tanaka (1912 : 102–105, pl. 26), it differs in fin structure in the same way that it differs from *Dalatias,* and further, in that the pectoral fins are rounded; the dentition, however, is similar; further differences are the conically rounded instead of depressed snout and the very large instead of small spiracles. From *Somniosus* it differs in approximately the same fin characters that separate it from *Dalatias,* and in having a much larger spiracle and many fewer teeth, of different form: the upper ones are more needle-like and the lower ones are much less strongly oblique; it differs further in having the center of the denticles pit-like instead of being elevated, with a posterior point.

From *Heteroscymnoides,* as described by Fowler (1934: 239, fig. 4; 1941: 273, fig. 10), it is separable by the form of the caudal fin, which has a horizontal axis and the epaxial part rather more instead of distinctly less expansive than the hypaxial part, and in having the second dorsal fin lower and longer on the base (in the structure of both these fins *Heteroscymnoides* is intermediate between the primitive forms *Dalatias, Heteroscymnus,* and *Somniosus,* and the more specialized *Isistius, Euprotomicrus,* and *Squaliolus). Euprotomicrus* further differs from *Heteroscymnoides* in the posterior displacement of the first dorsal fin, the much shorter and transversely rounded rather than depressed snout, the pitted instead of keeled and spiny denticles.

The characters of the diverse genera that have constituted the Dalatiidae suggest two main phyletic lines, corresponding with the main divisions of the accompanying analytical key, but the interpretation cannot be regarded as certain. The generic characters further suggest, by no means uniquely, a complicated phylogeny, in which similar features in different genera must have evolved independently. Thus the lower teeth presumably changed from erect to oblique in each of the two main groups. Primitive and specialized features are complexly associated in different combinations in the several genera—a common if not usual situation. No simple evolutionary tree (or "bush") can be reliably constructed on the basis of the available evidence. The apparent course of differentiation varies in accordance with the character on which attention is focused and there appears to be no securely objective basis on which to choose between the characters to be emphasized.

In the current classifications, reflected in Bigelow and Schroeder's treatment (1948), the presence or absence of spines in the dorsal fins is given prime and, we think, undue weight. The Squalidae and the Dalatiidae are separated almost solely on this basis. The virtual lack of other diagnostic characters and the strong indications that the spines have undergone obsolescence in more than one phyletic line render the family distinction seemingly artificial and unnatural. In some genera classed in the Squalidae, such as *Centroscymnus,* the dorsal spines are much reduced. Complete obsolescence of the spines would render *Centroscymnus* scarcely separable from *Somniosus,* a large and sluggish shark that might be expected to have lost this armature. Other genera referred to the Squalidae and the Dalatiidae are rather similarly paired, suggesting the multiple origin of the nominal group Dalatiidae. Further evidence on the unnaturalness of the Dalatiidae as currently defined is furnished by *Squaliolus,* which though classed in the Dalatiidae and by some even synonymized with *Euprotomicrus,* retains the first dorsal spine. *Squaliolus* seems to be a terminal element on a phyletic line quite different from that which seems to have led from *Centroscymnus* to *Somniosus* (see generic analysis). It would be extremely difficult to imagine the origin of all "Dalatiidae" from either *Somniosus* or *Squaliolus*. For these reasons it is suggested that the Dalatiidae be fused with Squalidae. Echinorhinidae, then, should likewise be synonymized with Squalidae. Pending thorough morphological studies and a general revision of the squaloids, the two groups thus demoted from family rank may perhaps be retained tentatively as subfamilies, Dalatiinae and Echinorhininae.

That *Euprotomicrus* is a highly modified terminal product of specialization is indicated by the characters that give this genus such an unusual appearance (p. 161), and by the transverse mouth, with very long lateral grooves; the great modification of the teeth, with extreme dimorphism in the two jaws; the peculiar, pitted, quadrate denticles; the great vertical expansion of the upper caudal lobe and the marked abbreviation of the lower lobe; and the greatly reduced number of vertebrae.

OUTLINE OF RELATIONSHIPS

- 1a
  - 2a *(Dalatias)*
  - 2b
    - 3a *(Heteroscymnus)*
    - 3b *(Somniosus)*
- 1b
  - 4a *(Isistius)*
  - 4b
    - 5a *(Heteroscymnoides)*
    - 5b
      - 6a *(Squaliolus)*
      - 6b *(Euprotomicrus)*

ANALYTICAL KEY TO THE KNOWN GENERA OF DALATIINAE

1.

a. Caudal axis strongly upturned; epaxial part of caudal fin little expanded; subterminal caudal notch strongly developed. Mouth more arched and lateral grooves shorter and shallower. Spiracle small. Larger, about 30 cm. at birth and commonly longer than 1 meter as adult. Chiefly in boreal and temperate seas; probably largely demersal.. 2

b. Caudal axis scarcely upturned or (in *Heteroscymnoides*) weakly upturned; epaxial part of caudal fin much expanded (moderately so in *Heteroscymnoides*); subterminal notch in caudal fin obsolescent (weak in *Isistius*). Mouth essentially transverse; lateral grooves very long and deep. Spiracle large. Small size, unknown over 50 cm., and most specimens well under 30 cm. Chiefly in warm seas; probably largely pelagic.................................. 4

2. (1a)

a. Lower teeth erect and serrate..*Dalatias*

b. Lower teeth directed outward and smooth-edged.. 3

3. (2b)

a. First dorsal fin larger than second and with angular apex; tip of pectoral angular .... *Heteroscymnus**

b. First dorsal fin no larger than second and with rounded apex; tip of pectoral rounded..*Somniosus*

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* *Heteroscymnus* may differ from *Somniosus* in other characters, such as dentition or denticle structure, that were not fully described by Tanaka. If it does not, *Heteroscymnus* may be reduced to subgeneric rank or perhaps to the synonymy of *Somniosus*.

4.(1b)

a. Lower teeth erect. First dorsal fin more displaced backward, the end of its base over front part of pelvic base. Dorsal fins subequal. Subterminal notch in caudal fin definitely evident, though small. (Denticles quadrate, with median pit, but without root-like processes. Fins not clear-edged.) .... *Isistius*

b. Lower teeth strongly bent outward. End of base of first dorsal fin well in advance of pelvic insertion. Second dorsal longer-based than first. Subterminal notch of caudal obsolescent 5

5.(4b)

a. Denticles triangular, keeled, ending in a spiny point. Base of second dorsal not more than one-half longer than base of first dorsal. Caudal axis moderately upturned; epaxial part of caudal distinctly less expansive than hypaxial part. Snout depressed. Fins entirely blackish, not clear-edged. (First dorsal without spine, beginning far in advance of middle of total length, over pectoral base. Snout much produced.) .... *Heteroscymnoides*

b. Denticles quadrate, with central pit and with roots at the four corners. Base of second dorsal much more than twice as long as base of first dorsal. Caudal axis scarcely upturned; epaxial part of caudal about as greatly expanded as hypaxial part. Snout scarcely depressed. Fins blackish at base, transparent outward 6

6.(5b)

a. First dorsal with a definite spine, beginning before middle of total length, much nearer pectoral than pelvic base. Snout much produced and sharper .... *Squaliolus*

b. First dorsal without trace of spine, beginning behind middle of total length, much nearer pelvic base than pectoral base. Snout blunt and broadly rounded. (Other differences outlined on p. 161.) .... *Euprotomicrus*

DESCRIPTION OF SPECIMEN

The body is essentially cylindrical in cross-section. In the region of the gill slits and in the anterior part of the trunk, where the area of cross-section is greatest, the width of the body equals its depth. The snout at its base is about 0.1 wider than deep. Toward the base of the pelvic fins the ventral surface becomes flattened and the width becomes restricted to about 0.7 the depth. Behind the end of the second dorsal base the body becomes depressed. Behind the pelvic fins a rectangular cross-section is gradually assumed, owing to the flattened lower and upper surfaces and the development of a ridge along the posterior part of the lateral line and of another ridge along the ventrolateral edge of the caudal peduncle. As the upper of these two ridges begins more anteriorly, the cross-section in the region below the second dorsal base, and to a slight degree farther forward, is somewhat pentagonal. Between the dorsals and in front of the first dorsal is a weak ridge along the midline. Between the anus and the base of the lower caudal lobe is a pair of moderately conspicuous grooves, rather close together. There are no precaudal pits. The distance from the tip of the caudal fin to the front of the anus is contained about 1.85 times in the distance thence forward to the tip of the snout. The greatest depth is contained 7.4 times in the length to the subcaudal origin. The least depth of the caudal peduncle is contained 1.6 times in the orbit (excluding the notches).

The ventral contour is nearly straight from the mouth to the caudal base. The dorsal contour curves gradually downward from above the end of the pectoral fin to the base of the caudal. As seen from the side, the head is almost bullet-shaped, with the snout very broadly rounded. As seen from above or below, the lateral contours converge forward in nearly straight lines to the rear of the nostrils, where the width is approximately equal to the preocular length. The outlines are strongly concave between the nostrils and the almost hemispherical tip of the snout. The snout is relatively short in front of the eye but moderately long in front of the mouth: the preocular length is contained 1.7 times in the preoral length, which approximates the distance from the middle of the mouth to the first gill slit.

The nostrils are unusually far forward and are more nearly lateral than ventral. As seen from the front, their axes converge strongly downward, so that, if extended to a common meeting, they would approximate an equilateral triangle. The least distance between the nostrils, at the ventral end, is approximately 0.4 the greatest distance between the outer edges of the narial pores. These pores, which form the upper end of the nostrils and are directed almost straight forward, are oval in cross-section, with a vertical height about two-thirds the transverse diameter, which is about two-thirds the length of the pupil. Just below the pore, the posterior rim of the nostril is inturned as a blunt flap, which is overlain by the almost hook-like process at the upper end of the thin narial valve. The total height of the nostril approximates 0.5 the preocular length of the snout, and is about 0.5 greater than the least internarial distance. As seen from below, the nostrils form an angle of 130°. As seen from the front, they form an angle of 95°.

The subcircular eye cannot be covered by eyelids. The pupil is round. The horizontal diameter of the cornea is about 0.1 greater than the vertical. The upper orbital margin is formed by two lines diverging at 140°, each ending in a notch, of which the one in front is smaller and shallower than the one just behind the upper third of the eyeball. The lower margin of the orbit is approximately semicircular. The surfaces of the eyes converge downward at an angle of about 38°. The eye is bisected by the body axis. The interorbital is strongly convex.

The spiracles are very large. The width (height) is about equal to the length of the pupil, is about 0.5 the orbital diameter, excluding the notches, is about two-thirds the least distance between orbit and spiracle, and is about 0.25 the interspiracular distance. Their axes converge upward at an angle of 72°. They are located about midway, vertically, between the eye and the dorsal profile. Each spiracle is roughly semicircular, with the posterior edge nearly straight. Toward the front is a conspicuous crescentic septum, fimbriate on its posterior edge.

The gill slits are excessively short. The second and longest is approximately 0.5 as high as the spiracle. Posteriorly the height decreases to the fifth, which lies just in advance of the insertion of the pectoral fin. This last slit is hardly more than a pore, less than 0.25 the height of the spiracle.

The main part of the mouth is an almost transverse slit, with the perpendicular only about 0.1 the chord, which about equals the preocular length. From each angle there extends backward and slightly outward a deep groove, which is contained about 1.4 times in the width of the mouth proper. Around the corner of the mouth is a thick fold, completely hidden when the mouth is closed. The mandibular part of this fold is very short and weakly developed, whereas the anterior part is a very conspicuous soft fleshy structure lying in a deep recess, which is continued backward as the posterior groove and forward as a cavern. Within the corners of the mouth the suborbital skin forms a broad semicircle before it becomes attached toward the midline. From this region of attachment a fold of skin separates the upper jaw from the thick fold previously described. There is a corresponding but much thinner fold against the lower jaw. The pocket immediately in front of the upper jaw is deeper than the corresponding mandibular pocket, and has a fringed edge. The posterior grooves of the mouth converge to an angle of about 40°.

The teeth are extremely unlike in the two jaws. Those in service in the upper jaw form about 4 rows, with the teeth of the adjacent rows alternating, so that the tooth arrangement is in quincunx. Each tooth is narrowly triangular and needle-pointed and has a narrowly forked root. In the lower jaw, in contrast, only a single series functions. The lower teeth are bent outward, so that those near the center of the jaw diverge at an angle of about 43°. The outer exposed edge is weakly convex and only slightly oblique. The inner edge is strongly oblique and is slightly concave, especially toward the sharp tip. These lower teeth are very much compressed and have a flat outer surface, contrasting with the rounded outer surface of the much narrower upper teeth. The inner edge of each crown contacts the base of the crown of the next tooth inward and is overlapped by the strong, rather pointed shoulder of that tooth. The lower teeth number 11+1+10 (the 11 on the left side include a very small one in the rear). There is no trace of denticulations on either upper or lower teeth.

The denticles are of two types, both of which are quadrate, with incurved edges, laterally projecting roots from the corners, and a deep hollow center. They agree in showing no obvious distinction between pedicel and blade.

In about every fourth to sixth row of small denticles is one about 2 or 3 times as long on each side. These larger denticles have strongly concave margins and, in addition to the central pit, a pit in each angle. Some have additional pits around the periphery of the median one. To the naked eye, the smaller denticles are scarcely visible, but the large ones look like minute scattered warts. The pattern of the denticles is approximately uniform over the body and head.

The lateral-line pores are rather irregularly spaced. There are 60 between the verticals from the pectoral insertion and the origin of the upper caudal lobe. The series continues for about 8 pores along the anterior half of the caudal axis. The lateral line is continued forward as a series of 19 pores to one that lies just above the spiracle. The pore just anterior and inside the last-named pore is the outermost in a cross-commissure of 9. Near the midline, just in advance of this commissure, is a pair of well-separated pores. Anterior to the outermost pore of the commissure a slightly sigmoid row of 22 pores extends to opposite the front of the eye. The same series is continued forward, curving inward, toward the tip of the snout. On the interorbital region, inside the supraorbital row on each side, is a considerable scattering of pores. Pores are also scattered behind the upper posterior part of the infraorbital series, and across the lower part of the snout, between the middle sections of these series. The preorbital file, however, is simple. On the lower side of the snout the pores tend to be concentrated in a zigzag cross-commissure and in a rather V-shaped file behind the inner tips of the nostrils.

There are no obvious luminous organs. In life, however, the skin was very slimy and it is not impossible that the mucus may be luminous.

There is no trace of spines in any of the fins, either in external view or on the X-ray plates. The dorsal fins are very dissimilar in size. The base of the anterior fin is hardly as long as the eye. It begins midway between the margin of the caudal fin and the middle of the eye (it is indicated in the figure about one pupil-length too far forward). The upper-anterior angle of this fin is very broadly rounded and the upper-posterior angle is sharply pointed. The height of the fin is about twice its basal length. The interdorsal space is 0.3 longer than the distance between the end of the second dorsal base and the beginning of the upper caudal lobe. The base of the second dorsal is about thrice as long as that of the first, and in depressed length more than twice as long. Its upper-anterior angle is very broadly rounded and its posterior tip is sharply pointed. The vertical from the origin of the first dorsal is 3.5 times as far from the end of the pectoral base as it is from the pelvic insertion. The origin of the second dorsal is approximately over the posterior end of the pelvic base. The distance from the tip of the second dorsal to the beginning of the upper caudal lobe is approximately equal to the length of the orbit, including the notches.

The caudal fin is nearly symmetrical, with both lobes greatly expanded. The fleshy axis expands before its middle to a width about 0.5 greater than the least depth of the peduncle. The posterior, acuminate tip of the urostyle reaches the margin on the lower posterior edge of the upper lobe. There is, however, little trace of a subterminal notch. The vertical expansion of the upper lobe approximately equals that of the lower, but since the upper lobe begins a pupil's length farther back and has a more oblique front edge, about half its area is behind the tip of the lower lobe. The angle formed by the slightly convex front edges of the lobes is 79°. Each lobe is broadly rounded, with a weakly convex posterior edge. The margin of the lower lobe slopes upward and slightly backward; that of the upper lobe, upward and slightly forward. The upper-posterior margin of the lower lobe, below the end of the urostyle, is rather evenly and deeply concave. The distance between the tips of the lobes is nearly 0.2 greater than the distance between the origin of the lower lobe and the tip of the urostyle.

The pectoral fin in ventral view forms roughly an equilateral triangle, with the anterior and posterior edges moderately convex and the lower-posterior angle broadly rounded. The upper or anterior half of the fin is approximately horizontal; the lower, or posterior, part, arched downward. The fleshy pelvic bases are approximately flat and horizontal. The pelvics are elongate basally, very broadly rounded at the outer-anterior corner, and very sharply pointed on the inner-posterior angle. The outer edge is concave just in advance of the sharp posterior tip. The fins are in contact over and behind the anus, in a straight line about two-thirds the greatest length of the fins. The tips extend to behind the vertical from the middle of the second dorsal base. Just behind the anus, between the inner ends of the pelvic bases, is a pair of valve-like flaps.

Perhaps in correlation with the dwarf size, the segments are very few. Between the front edges of the paired fins about 22 muscle bands are indicated by slightly depressed and slightly darkened lines crossing the belly. The myomeres are very weakly angulated on the sides and on the belly. The individual vertebrae, clearly evident in the X-ray photograph (plate VI), are elongate and much constricted medially so that the adjoining halves form spindles, much as in a teleost. There are only 48 between the head and the origin of the upper caudal lobe. Along the axis of the caudal fin the vertebrae become much reduced and difficult to see in the X-ray photograph. There are 6 vertebrae anterior to the insertion of the pectoral fin, 21 between the insertions of the paired fins, and 21 between the pelvic insertion and the origin of the upper caudal lobe. The contrast between these vertebrae and the disc-like vertebrae of most sharks is very great, but the condition in *Euprotomicrus* is approached by that in certain other squaloid sharks (Hasse, 1879–1885).

The fins are only partly covered with denticles. The pectoral has a thick covering on its basal third to two-fifths, with a further extension outward near the front edge. The pelvic has denticles only on the swollen fleshy base. The caudal is well covered over the fleshy axis and outward over two-thirds to one-half of each lobe. The dorsals are almost entirely devoid of denticles, except at the extreme base. Beyond the area covered by denticles, the fins are extremely thin and flexible and clearly show the ceratotrichia.

In the water this little shark appeared brown, but when brought on deck seemed blackish. Some myctophids exhibit a similar apparent color change. In alcohol the specimen is blackish, with purple and brown sheens. The blackish body color extends over the denticle-covered part of the fins, with diffusion somewhat farther out. The outer edges of the fins, however, are crystal clear, in a pattern well shown in the figures. The urostyle is black to its slender tip. The concealed parts of the mouth are whitish, as is also its anterior exposed margin medially. The thin outer part of the narial valve is clear of pigment.

When seen at the surface the little shark was swimming slowly with an undulatory movement, progressing in an approximately constant direction as though it was not especially attracted by the light. A first miss with the dip-net did not seem to frighten it. It showed extremely little activity when picked out of the net and even when placed in formalin did not become very active. It was very slippery, owing to a profuse coating of slime. Quantities of mucus were exuded onto the net.

Proportional Measurements

The measurements are expressed in thousandths of the total length (233 mm.). They were made before the specimen was transferred from formalin to alcohol. In comparison, proportions for a few critical measurements are given for the holotype, 192 mm. in total length, on the basis of measurements made for us through the kindness of Dr. Léon Bertin.

Body.—Predorsal length, from tip of snout to extreme front edge of dorsal base, 527 (521 in type). Distance between dorsal origins, 152 (167 in type). Interdorsal space, 122. Origin of second dorsal to margin of upper caudal lobe, 314. Tip of second dorsal to caudal margin, 190. Pectoral insertion to dorsal origin, 300 (312 in type). Prepectoral length, 245. Prepelvic length, 614. Between insertions of paired fins, 379. Greatest body depth, 116. Least depth of caudal peduncle, 21. Greatest body width, 117. Width of caudal peduncle at front of caudal fin, 22.

Head.—Length to nearest point of first gill slit, 189 (177 in type). Width between first gill slits, 111. Preocular length of snout, 63. Preoral length of snout, 102. Snout tip to outer end of nostril, 34. Nostril length, including dorsal pore, 30. Least internarial width, 21. Width between inner edges of dorsal pores of nostrils, 40. Width between tips of narial flaps, 53. Least distance from nostril to orbit, 33. From nostril to mouth, 72. Front of mouth to line joining ends of gape, 52. Width between outer edges of concealed lips, 67. Width between ends of oral grooves, 92. Orbit to end of oral groove, 60. Orbital notch to end of oral groove, 63. Least suborbital width, 24. Orbit length, between inner edges below notches, 36. Between extreme ends of orbital notches, 46. Orbit height, 30. Fleshy interorbital width, 82. Width between orbits, ventrally, 68. Least interspiracular distance, 69. Postorbital notch to spiracle, 30. Between outer-ventral and inner-dorsal ends of spiracle, 20. Anteroposterior width of spiracle, 13. Spiracle to end of oral groove, 38. Spiracle to pectoral insertion, 110. Between front of first and fifth gill slits, 50. Longest gill slit, 16.

Fins.—First dorsal: base, between extreme ends, 29; origin to upper-anterior tip, 46; upper-posterior edge, 31; lower-posterior edge, 37. Second dorsal: base, 86 (88 in type); origin to upper-anterior tip, 39; upper edge, 104; lower-posterior edge, 50. Caudal: upper lobe, extreme origin to farthest point, 142; lower lobe, origin to tip, 120; dorsal origin to tip of urostyle, 129; dorsal origin to nearest point on margin, 102. Pectoral (appressed against body): base, 39; insertion to upper-posterior tip, 98 (89 in type); to lower-posterior tip, 101; posterior edge, 85; extreme width, 91; lower posterior edge, 71. Pelvic: base, 68; insertion to outer-anterior tip, 55; outer-posterior edge, 72; inner-posterior edge, 48.

SUMMARY

A very peculiar small shark collected at the surface over deep water nearly 500 miles off California is identified as *Euprotomicrus bispinatus* (Quoy and Gaimard). It is the second specimen of the genus known from the Pacific Ocean. *Euprotomicrus* is regarded as monotypic, since *Squaliolus*, also treated as monotypic, is interpreted as generically distinct. *Euprotomicrus hyalinus* Eigenmann and *Squaliolus sarmenti* de Noronha are synonymized with *E. bispinatus* and *S. laticaudus* Smith and Radcliffe, respectively. *Euprotomicrus* is a highly modified squaloid shark referable to the Dalatiidae as currently defined. Generic relationships within this group are rendered uncertain because of convergent evolution. Many species show primitive and specialized features in confusing combinations. The validity of the separation of the Dalatiidae from the Squalidae is discounted, for the dorsal spines seem to have become lost on several phyletic lines. Echinorhinidae is also synonymized with Squalidae. Provisionally these groups are retained as subfamilies, Dalatiinae and Echinorhininae. The dalatiine genera seem to form two main lines (see analytical key, p. 164). The new specimen is described and its measurements are listed.

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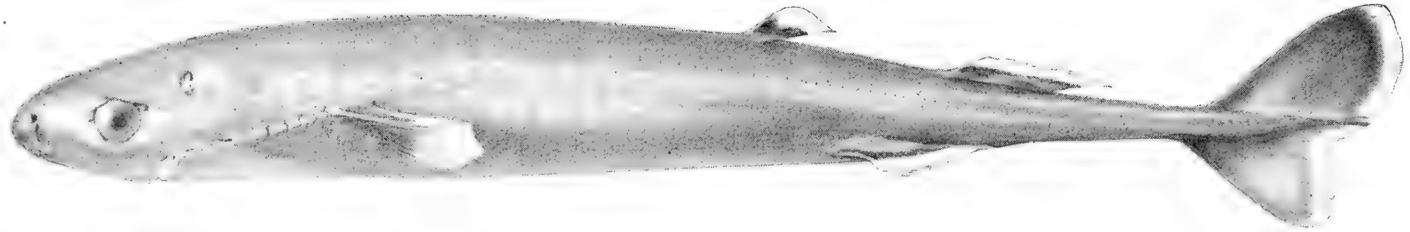

PLATE IV

FIGURE 1. Lateral view of a 233-mm. female specimen of *Euprotomicrus bispinatus*, a peculiar little shark captured at the surface nearly 500 miles off California. All drawings by Alma Froderstrom.

FIGURE 2. Ventral view of the same specimen.

PLATE V

FIGURE 1. Mouth and teeth of the same specimen.

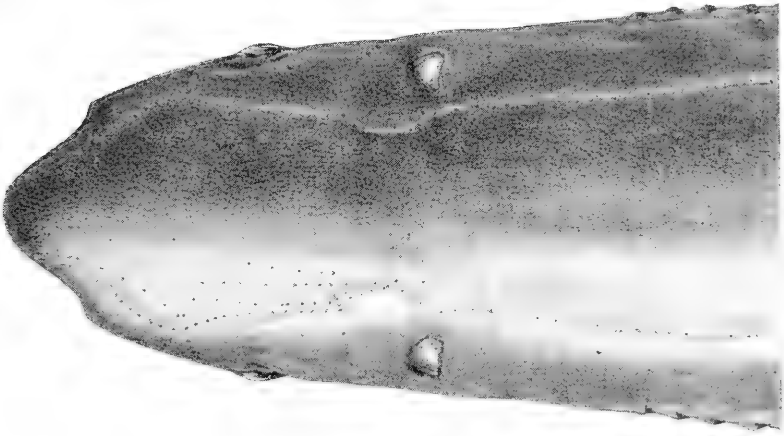

FIGURE 2. Top of head of the same specimen.

PLATE VI

X-ray photograph of the same specimen, to show, in particular, the vertebrae, which are elongate and much constricted medially, so that the adjoining halves form spindles. Photo by J. L. McHugh.

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A REVISION OF THE NORTH AMERICAN SPECIES OF *OXYTROPIS* DC.

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Introduction

The review of the North American species of *Oxytropis* presented below had its origin in a less ambitious project. The species first to engage my attention were those native to the western United States, and I planned originally to limit my studies to the area west of the Great Divide and south of the Canadian border. It was already clear that accounts of the genus current in such floristic works as Rydberg's *Flora of the Rocky Mountains* failed in their primary purpose of making identification of specimens easy or even possible, a state of affairs confirmed by chaos on the shelves of many herbaria. The species listed seemed far to outnumber those existing in nature, while their names, as they had shifted back and forth in the past few decades between *Aragallus* and *Spiesia, Oxytropis* and *Astragalus,* had acquired an abundance of disordered synonyms. Several of the older binomials, imperfectly understood in the first instance, had assumed by accretion or altered emphasis connotations far removed from their respective original concepts, while a number more, lying fallow in the pages of periodicals, had never been evaluated in relation to their congeners. In recent years it has become impossible to determine from any published source either how many species occur in our western mountains or by what names they should properly be known.

As work progressed on the small group of Rocky Mountain and Great Basin species, it became necessary to examine much material of extralimital origin. For example, *O. viscida,* which ranges northward to Alaska and eastward in highly interrupted stations to Wisconsin and Quebec, cannot be adequately understood when viewed only in its western aspects. Similarly *O. deflexa,* a common cordilleran species, extends into the far Northwest, and in various forms through eastern and subarctic Asia, whereas the constellation of forms grouped below under *O. campestris* is merely a segment of a widely diffused boreal complex. Ultimately it was found that all but a handful of the New World species had thus been surveyed in some detail, and it seemed desirable and perhaps useful to include these few in the projected revision so as to gather together, for the first time since Asa Gray's tentative memoir of 1884, a record of the genus as it survives or flourishes on this continent.

Thus I have been led afield into regions where I have neither travelled nor collected and with whose flora and geography I am acquainted only by hearsay. As regards the Arctic species, except in a few instances where a contrary opinion seemed well grounded, I have accepted the conclusions of those better equipped by experience to pronounce judgment. I have felt justified in treating the species familiar to me in the West from a more critical point of view and it will be found that the varieties recognized within some of these are more finely drawn than elsewhere.

The taxonomic opinions presented below cannot in any sense be considered final. Even if the herbarium record were much more complete than it is at present, it is doubtful whether comparison of the external morphology of dried specimens, however careful or prolonged, will serve to illumine the problems of origin, variation, and interrelationship raised by what Gray justly called the "*species perdifficiles*" which comprise a great part of the genus. I shall feel satisfied, however, if some small progress towards definition of our major forms, and toward a stable and accepted nomenclature, has been achieved.

OUTLINE OF THE TAXONOMIC HISTORY

The occurrence of *Oxytropis* in America was first inferentially noted in 1800 by Simon Peter Pallas, who recorded from Labrador an astragalus resembling *A. montanus* L. *(O. montana* [L.] DC.); but when the genus was established by DeCandolle two years later, it was based exclusively on Old World species. Our first endemic species was discovered on the Missouri River by John Bradbury in 1811, and described shortly afterward as *O. Lambertii* Pursh. At the same time Pursh listed, under the mistaken label of *O. argentata* (Pall.) DC., a second species, encountered by Lewis and Clark in Montana, but many years were to elapse before this came to be recognized as a purely American type, the handsome *O. Besseyi.* In 1823 Richardson announced the first Canadian station for *O. deflexa,* previously known only from Asia; while *O. splendens* and several high boreal species still confused with *O. campestris* and *O. uralensis* were among the collections brought back by the Franklin Expedition. Meanwhile Nathaniel Wyeth had discovered in western Montana the remarkable *O. Lagopus,* described by Nuttall in 1834; and the same year saw the first synopsis of the American species in Flora Boreali-Americana. In this important work Hooker first characterized *O. splendens,* now better known from collections of David Douglas, the new *O. foliolosa* from Alberta, and a number of distinct races subordinated to *O. uralensis, O. arctica,* and *O. campestris* which, as yet known from all too scanty material, could not well be appreciated at their true value. The account of *Oxytropis* by Torrey and Gray in their Flora of North America (1838) followed that of Hooker in nearly all details, but derived additional luster from Nuttall's manuscripts, including the descriptions of six new species collected by the author on his transcontinental journey with Wyeth. These were the first American species to be described by a botanist who knew them in the field.

At this point the care of *Oxytropis* passed into the capable hands of Asa Gray and, with one exception, remained there until his death. Bunge, to be sure, put out a monograph of the entire genus in 1874, but his knowledge of the American species, derived from Gray's writings only meagerly supplemented by materials in European herbaria, was perforce limited; apart from a few valuable comments the work is of minor importance in our field. Gray published two papers on the genus. The first formed part of his revision of *Astragalus* in 1864, but here, although *O. podocarpa* was first described in the rank of species, the sixteen members of the genus (and additional varieties) previously accepted were reduced by half. The treatment reflects an extreme caution appropriate perhaps to the exiguous data at hand, and did little to advance an understanding of the species. An opportunity to compare the material of *Oxytropis* at Kew, in 1880, with his own rapidly accumulating collection enabled Gray to return to the genus with new insights and to resolve many difficulties, and the resulting synopsis of the genus in 1884 stands as a small but enduring monument to his genius. Sixty-odd years of exploration and collecting may have modified the outlines here and there, but have scarcely disturbed the basic specific concepts defined in this masterly revision.

The death of Gray in 1888 was felt by some contemporary botanists, especially in the West, as a liberation, and the turn of the century witnessed great activity not only in the field but in the proliferation of species, often hastily proposed. In 1899 Greene took up *Aragallus* Neck. as a substitute for *Oxytropis* (as also for *Spiesia* Neck., resurrected shortly before by Otto Kuntze), and Aven Nelson, whose interest in the genus was to continue for many years, published an important paper on the species known to him in Wyoming and the Rocky Mountains. In 1905 Greene, hitherto content with combining the older epithets in *Aragallus,* proposed nineteen critical species, each based on one or two specimens only, but these have nearly all fallen into disrepute. About the same time Rydberg, in occasional papers and floras spaced over a period of three decades, began to contribute novelties or new definitions, thereby adding more to the literature and synonymy than to a true understanding of the genus. Rydberg's work on *Oxytropis,* which was to have culminated in a monograph for the North American Flora, was cut short by his death in 1931. In 1928 St. John published a revision of a small group of species native to the state of Washington, and quite recently C. L. Porter, an active student of *Oxytropis* in the Rocky Mountain states, discovered and described the rare and peculiar *O. obnapiformis.* It is curious that Marcus Jones, who devoted so many years to *Astragalus,* evinced almost no interest in the related *Oxytropis;* it may be surmised that he found Gray's classic paper adequate.

During the post-Grayan period the *Oxytropis* species of the Northeast and of the Arctic received comparatively little attention from botanists. In 1894 Britton described the remarkable *O. Belli* from Hudson Bay, and the Amundsen expedition brought back *O. Roaldi* from the Yukon coast in 1906, but nothing much of a critical nature found its way into print until Fernald's paper of 1928. Although primarily concerned with *Oxytropis* in the Northeast, Fernald discussed several extralimital problems, and his short treatise stands comparison for novelty and interest only with Gray's revision of 1884. In the last few years the work of Polunin, Hultén, and Porsild has greatly enriched our knowledge of the genus in high latitudes and brought to light two marked Alaskan species.

The allusion above to a projected monograph by Rydberg is based on the fact that the genus was keyed out in North American Flora, 24:262, 1929, and a summary discussion of the *Oxytropis* versus *Aragallus* controversy published during the following year (in Amer. Jour. Bot., 17:236–238). The material at the New York Botanical Garden is fully annotated in Rydberg's hand and several unpublished species thereby indicated, but Dr. Gleason assures me that no manuscript was found among Rydberg's papers. Perhaps it is not altogether unfortunate that the monograph was never written, since Rydberg himself stated, in the paper just referred to, that the genus contained "about 70 North American species," a much greater total than anyone, I think, is likely to concede today. The present treatment maintains only twenty-two major species which, with twenty-one additional minor taxa such as were customarily accepted by Rydberg as species of the first rank, brings the roll call for America to forty-three.

VALIDITY OF THE GENUS

The status of *Oxytropis* as a genus distinct from *Astragalus* has been argued for more than a century and unanimous decision is still to be reached. Systematists in favor of reducing *Oxytropis* to subgeneric rank have not seriously questioned the naturalness of the group or its presumed monophyletic origin, but have pointed to the lack of a distinctive habit and of absolute criteria by which the two genera can be set apart. Their opponents, no doubt dreading the changes in nomenclature brought about by wholesale transfers from *Oxytropis* to the older genus, have stressed the advantages of maintaining an old and honored generic concept.

It is a truism that no genus can be defined or fully described until the last surviving member has been made known, and when DeCandolle erected *Oxytropis* to contain a part of the Linnaean *Astragalus,* he could scarcely foresee the number or variety of species which subsequent exploration would bring to light. Yet since *Oxytropis* was founded in 1802, only two species have turned up to challenge the original characterization. As first set forth, *Oxytropis* was characterized by the beaked keel-petals and the introflexion of the pod's ventral suture, as opposed to the muticous keel of *Phaca* and *Astragalus,* with their pods unilocular or bilocular (from the dorsal suture) respectively. The reduction by Gray of *Phaca* to *Astragalus,* almost everywhere admitted as inevitable, and the discovery of a vast number of new species in the genus so formed, allowed in *Astragalus* an extreme diversity in structure of the legume, and it then became impossible in practice to distinguish *all* species of *Oxytropis* on technical features of the pod. Only the beaked keel, certainly a poor character in the order, remained, and this was further shaken by the description of two perfect astragali, *A. nothoxys* Gray and *A. acutirostris* Wats., with distinctly cuspidate keel. As early as 1827 Sprengel (Syst., 4^2.), without discussing the merits of DeCandolle's genus, summarily transferred a number of species back to *Astragalus,* and Baillon (Hist. Pl., 2: 281, footnote 8, 1870) cast further doubt on the validity of *Oxytropis.* Subsequently Rouy (Fl. France, 4: 186, 1897), quoting the "oxytropoid" astragali described by Gray and Watson, removed all the French species of *Oxytropis* into a subgenus of *Astragalus.* Similar arguments were advanced by Hegi (Ill. Fl. Mittel-Eur., 4: 1403, 1923) and by Wheeler (Leafl. West. Bot., 2: 209, 1939). It should be borne in mind that Bunge, the monographer of Old World *Astragalus* and of *Oxytropis,* Taubert (in Engler's Pflanzenfamilien), as well as Gray, Bentham and Hooker, Dalla Torre and Harms, and a host of others have supported *Oxytropis,* as do the majority of contemporary botanists.

If the character made the genus, the existence of a beaked keel in *Astragalus nothoxys* (even though absent in some individual plants of the species; cf. *Hamosa Gooddingii* Rydb.) would go far to invalidate *Oxytropis* as a natural genus, for this is an undoubted *Astragalus,* closely related to congeners with muticous keel native to the same region, and having a pod wholly at variance with anything known in *Oxytropis.* An approach from this angle is fundamentally mistaken. A genus is perceived by the sum of characters common to its members, not by one or two which may prove unique to it and thereby become of practical use in a key. The gift of speech is a character of *Homo,* but a dumb man is not classified with the monkeys. The so-called "oxytropoid" astragali can in no sense be said to bridge the gap between their genus and *Oxytropis* and are no real obstacle to recognition of the latter.

The controversy cannot be settled out of hand and an opinion that is not based on profound knowledge of both genera in all their ramifications is not worth the trouble of expression. Evidence much more compelling than a superficial resemblance in habit or properties between *A. alpinus* and *O. foliolosa* in the Rocky Mountains and between *A. mollissimus* and *O. Lambertii* on the Western Plains (as adduced by Wheeler, 1939) must be presented before the case against *Oxytropis* can be satisfactorily proven. Until it can be shown that the gap between the two genera is at some point no greater than that existing between species-groups within *Astragalus* as generally received, that there are species referable with equal justice to either genus, or that *Oxytropis* is of itself polyphyletic and derived from several strains of a hypothetical "*Proto-Astragalus,*" the submergence of *Oxytropis* in the uncharted ocean of the older genus will do nothing to clarify relationships or promote a stable nomenclature in the Astragalanae.

There is a leaf character, so far as can be discovered not mentioned in the literature, which may perhaps provide an additional criterion for the genus. The leaflets in all species of *Oxytropis* familiar to the writer are decidedly inequilateral at the base or, when so narrow that the asymmetry becomes obscure at the insertion of the petiolule, they are introrsely falcate, the lower margin being longer than the upper (leading) edge, presumably composed of larger or more numerous cells. In some individual leaves, or in the leaves of some individual plants, the asymmetry is admittedly almost imperceptible, but has been found clearly expressed in some specimens of every species examined in connection with this paper, and seems to be at least latent throughout the genus. No trace of asymmetry has been seen in the leaflets of any genuine species of *Astragalus.* Whether ultimately significant or not, the point is worth systematic investigation.

PHYLOGENY AND INFRAGENERIC DIVISIONS

Bunge's monograph (1874) postulated four subgenera in *Oxytropis. Ptiloxytropis* (of Turkestan) and *Physoxytropis* (the American *O. multiceps)* were each based on a single species characterized by a small legume enclosed by the unruptured calyx. The remaining (179) species, with pod at length exserted from the broken calyx, were distributed between *Phacoxytropis,* with no septum in the pod, and *Euoxytropis,* with pod always ventrally and sometimes also dorsally septate. Only one American species, *O. deflexa,* was admitted to *Phacoxytropis,* and thus all but two of ours fell into the last subgenus. This was further broken up into thirteen sections marked by peculiarities of vesture, fruit-structure, and arrangment of the leaflets along the rachis, six of them being represented in this continent. Gray's second revision (1884) established four sections: *Calycophysae* (= *Physoxytropis), Montanae* (= *Phacoxytropis), Campestres,* and *Physocarpae* (= parts of *Euoxytropis).* Similarly Rydberg, in 1917, separated *Aragallus* of the Rocky Mountains and adjacent plains into six series: *Deflexi* (= *Montanae* Gray), *Nani* (= *Physoxytropis* Bge., enlarged), and four others more or less corresponding to some of Bunge's sections of *Euoxytropis.* While there is something to be said in favor of each of these neat arrangements, they fall short of a natural classification in that they contrive to separate, by undue emphasis on a single character, pairs of closely allied species, and at the same time claim no greater diversity between sections than between species within a section. Delimitation of infrageneric groups should not, of course, be attempted without a firm grasp of the genus as a whole, and lies beyond the scope of this paper. It seems wise to adopt no sectional groupings for the New World species until they have been fully correlated with their Asiatic congeners.

It is impossible, nevertheless, to survey even a segment of the genus without becoming aware that several fairly distinct groups exist, even if their evaluation is not possible at present. The species like *O. deflexa,* numerous in Asia, with their strong tendency to caulescence, stipules free from the petiole (but sometimes connate opposite the petiole), and pendulous pods, stand well apart from the rest. Both morphologically and in their preference for mesophytic habitats, these may represent a primitive line of development in the genus, and rather closely resemble some evidently primitive astragali. The arctic and alpine *O. nigrescens, Scammaniana* and *Mertensiana* (of § *Arctobia* Bge.), and *O. podocarpa* (of § *Caeciabia* Bge., differing in the stipitate pod) form an evidently related group, much alike in habit, stipule, few-flowered raceme, and other details. The center of their distribution lies in the Behringian region, although *O. podocarpa* ranges southward in the Rocky Mountains and recurs as a relict in Labrador and Baffin. In this alliance the branches of the caudex have a potential ability, not infrequently arrested in the individual plant, to elongate over a period of years, at length achieving a loosely matted rather than cespitose-acaulescent habit. The eglandular species with pseudo-verticillate leaflets (§ *Baicalia* [Stell.] Bge.) fall inevitably together, but the disposition of the leaflets is hardly a fundamental character. Our two species constantly so characterized, *O. splendens* and *O. Belli,* are no doubt related to each other, but *O. arctica,* with leaflets normally solitary but occasionally with a few disposed in pairs, closely approaches *O. Belli* in its fragile stipules and in the structure of the flower and pod. So also "*O. varians,*" with leaflets verticillate in variable degree, at the same time makes so close an approach to some forms of *O. campestris,* that it is here treated as part of that complex. Hultén has shown (Fl. Kamtchat., 3:103) that seeds of *O. erecta* Kom., a species of the *O. campestris* type with scattered leaflets, produced in cultivation plants with partly paired or verticillate leaflets. Hybridization may, however, play its part in this situation.

The glandular species of *Oxytropis* are commonly arranged in two series, one with verticillate (§ *Polyadena* Bge.), the other with scattered leaflets (§ *Gloeocephala* Bge.). Our sole representative of the glandular species, the polymorphic *O. viscida,* not only breaks down the distinction between Bunge's two sections by producing an occasional plant with numerous paired leaflets, at least in the mature secondary leaves, but so closely resembles forms of *O. campestris,* so readily hybridizes with that species, and varies in so nearly parallel a fashion, that a near affinity between the two can scarcely be doubted. In fact viscidity and its absence and both paired and solitary leaflets occur in each of the four possible combinations in species alike as to floral and carpological structures, and segregation of each series as a section tends to obscure rather than clarify the relationship between them.

The remaining American species, although they exhibit remarkable modification in the fruit, are similarly interrelated, and it is difficult to draw any but vague lines between them. The essentially boreal constellation of forms centering around *O. campestris* presents a basic pattern from which the rest, as they have migrated southward in times past into the diverse soils and climates of the Western plains and mountains, are most probably derived. In *Astragalus,* xerophytic conditions favor the development of exceptionally large, small, or otherwise diversified pods, and an analogous though less extreme modification is found in our species of *Oxytropis.* The valves of the pod in *O. Besseyi, O. obnapiformis, O. Lagopus,* and *O. multiceps* tend toward a papery and inflated state, while those of *O. Lambertii, O. sericea,* and *O. nana* are of tough texture and more closely invest the seeds. In each of these series reduction in size culminates in a pod so small that at maturity it remains enveloped by the unbroken calyx and the calyx itself becomes somewhat inflated and bladdery. When Nuttall discovered the extreme example of this sort in *O. multiceps,* he proposed for it a new genus, *Physocalyx,* and Bunge's subgenus *Physoxytropis* was based on the same. Rydberg's *Nani,* with the same character, took in *O. Lagopus* and *O. nana,* but the latter is doubtfully best referred there. In the series with thin-walled pod the pedicels (nearly always) become jointed to the axis of the raceme and the calyx and fruit fall together, sometimes before dehiscence. The pedicels of *O. nana* remain, as in *O. sericea,* firmly attached in fruit, and these two species appear closely related in other ways. It is possible that the "*Physocalyx*" condition has arisen as the end-product of two[1] separate lines, a fact which makes it unsatisfactory as a sectional character.

Finally we have a pair of small-flowered species, *O. Parryi* and *O. oreophila* (with a local satellite or derivative in *O. Jonesii* which can be considered with them), distributed around and within the Great Basin. They are much alike in facies, though the former has coriaceous and the latter membranous and inflated pods. They may be interpreted either as directly related, and then as forming a somewhat disjunct group of their own, or perhaps more correctly as parallel derivatives of the two principal series outlined above. Rydberg created a monotypic section for *O. Parryi,* perhaps justifiably, but placed *O. oreophila* with *O. podocarpa,* a certainly mistaken arrangement.

A hypothetical view of affinities in our species is presented diagrammatically in figure 1.

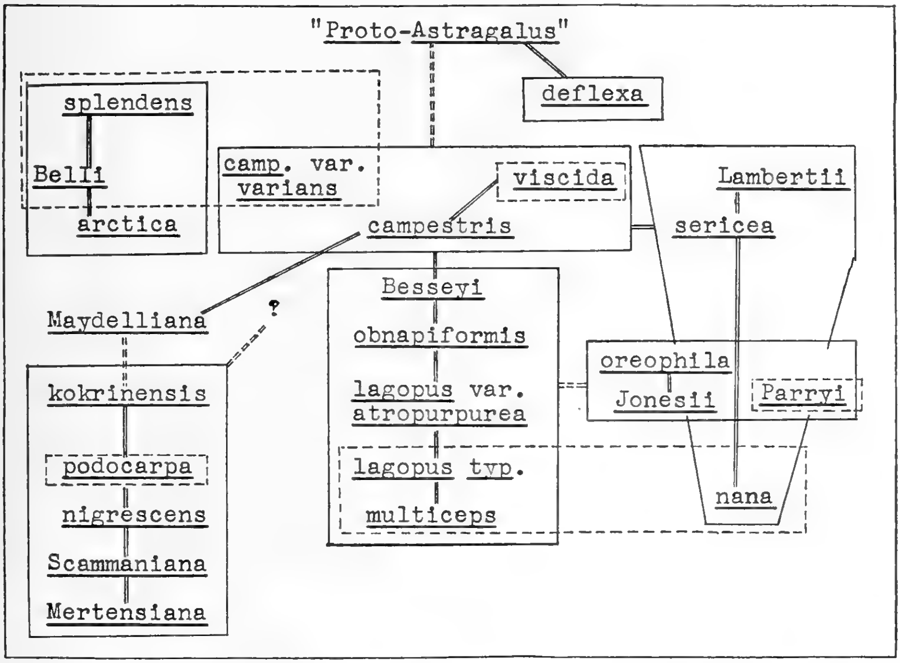

Figure 1. Hypothetical view of relationships in American species of *Oxytropis.* Solid lines enclose apparently well-marked groups; broken lines those species formerly included by authors in what are thought to be unnatural or insufficiently definite sections. Solid double lines indicate close relationship between groups or individual species; broken double lines less certain and doubtful affinities.

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[1] The Siberian *O. includens* N. Basil., sole representative of § *Angarida* Vass., seems to be a third, independent but parallel development; cf. Fl. U.R.S.S., 13:542, 1948.

CRITERIA

Variation within the species is so general in *Oxytropis* as to acquire almost the status of a generic character. Failure to appreciate the degree and direction of this inherent variability, often strikingly great, has led to a multiplication of supposed species and, as an inevitable sequel, has given the genus a reputation for difficulty only partly deserved. The principal unstable characters, and those which have been found useful for the purposes of classification during the present study, are as follows:

Stature. The repeated emergence in *Oxytropis* of pygmy and giant phases, noted in more detail in the ensuing pages, is a remarkable phenomenon in a perennial genus, especially when, as here, reduction or the reverse often extends not only to size of the plant-body but to the reproductive organs. Field experience suggests that these variations in size are to some degree inherited, not merely or at least not always expressions of season, site, or habitat. For example, Victorin and Rousseau (Cont. Inst. Bot. Univ. Montreal, 30: 32, 1940) report that plants of typical *O. johannensis (O. campestris* var. of this paper) and of their fma. *bicensis,* described as a dwarf race with short pod, maintained their differences when grown side by side in the garden, even to the extent of flowering at different periods. It seems probable that each species consists of several or many small races differing slightly in genetic constitution but experimental evidence on this point is still lacking. For the moment it is only possible to point out some of the more outstanding cases as expressed in the external morphology of the plants, remarking that these seem to occur for the most part in no more than sporadic fashion here and there in the range of their species, with intermediate states more common than the extremes. Occasionally a dwarf or giant race is supported by other characters or found to occupy a distinct area of its own, and these have been maintained as varieties.

Pubescence. The type of vesture clothing the herbage is usually uniform in the species but its density is variable, probably linked with edaphic factors. As a whole, however, the sorts of trichomes are too much alike to furnish valuable diagnostic characters. The two-armed (dolabriform or malpighian) hairs of *O. Lambertii* are an obvious exception. Hairs in the inflorescence, including the calyx and upper portion of the peduncle, are commonly of two sorts, one longer, with a tendency to be spreading and pale in color, and the other shorter, more nearly appressed and fuscous. The proportion in which the two sorts are mixed varies independently of other characters, and in the same species either sort may be absent, either predominant, or each may be of either color. In rare cases a particular combination has been found to possess some vague geographic correlation, but the rule is for widely divergent states to occur promiscuously and in close proximity.

Stipules. The importance attached to minute stipular characters by some students of the genus has been, I think, overestimated. On a single stem the stipules generally differ somewhat according to position in the year's cycle of growth, those of the resting or winter leaves being shorter, with shorter free blades, than the rest, and showing tendencies toward denser vesture and simpler venation. Similar differences, especially in the length of the blades, are often found in the same colony, and individuals with exceptionally long blades, often echoed above by elongated bracts, are common in the genus. Nevertheless the texture of the stipules, whether thin and fragile, firmly scarious, or stiff and papery, is characteristic and of great value. The presence or absence of bristly cilia on the margins of the blades is of occasional help in confirming an identification but neither state is invariable in any species. In a few boreal members of the genus some of these cilia are shortened and thickened into the form of clavate processes, and this seems to be quite often a specific character. It has been generally overlooked that the stipules in most of our acaulescent species are not only adnate to the petiole but strongly connate opposite it, in vernation forming a closed cylindric sheath, but this becomes so early ruptured by pressure of growth from within that it can be seen only by dissection of the terminal bud. Systematic investigation of this point might yield interesting results but entails such destruction of specimens that it is unlikely to provide a practical criterion.

Leaves. The leaves of the acaulescent species are inclined to be dimorphic, the lower shorter, with broader, fewer, and shorter leaflets. The amplitude of the leaflets is most variable, but their number to the fully developed leaf is a fairly reliable character.

Bracts. These structures are rather similar throughout the genus, differing a little in texture from herbaceous to submembranous between species and very greatly in size within the species. A bracteose condition, sometimes giving a distinctive leafy aspect to the raceme, occurs sporadically in many species of *Oxytropis,* and has formed the principal basis of several segregates in the past.

Calyx. The calyx offers a few specific characters. In two species and a variety of a third *(O. Lagopus)* it becomes inflated, enclosing the small pod; in the remainder, though often a little accrescent after anthesis, it is split by the tumescent ovary and laid back around the base of the pod. Calyx-measurements given below were taken from flowering material and sometimes do not allow for growth after the petals have fallen. The relative length of the calyx tube and teeth is pretty constant in some species but in others quite the opposite is true. The type of vesture, though not the color and very rarely the density of it, is occasionally diagnostic.

Corolla. Within reasonably narrow limits the length and amplitude of the petals are characteristic of the species, in spite of rare aberrant specimens. Their color is more constant than has often been claimed, though a few species, apart even from the polychrome hybrids, are indeed variable in this respect. The terminal cusp of the keel is quite inconstant in length and curvature, being at times reduced to a minute boss or knob, or alternatively much elongated in the same species, and then either straight or incurved.

Pod. As in the related genus *Astragalus,* the pod is here of the utmost importance in delimiting species, and yet it is deceptively variable so that a feature of it may offer a reliable criterion in one species and fail hopelessly in another. The texture of the valves is probably the most constant attribute of the legume and in doubtful cases, as in some races of *O. sericea* and *O. campestris,* may provide the sole clue to a plant's identity. The absolute and relative lengths of the body and beak, the diameter, and the degree to which the flange connecting the funicles (the false septum) is produced across the cavity are all decidedly variable. Shrinkage of the valves in drying, whether in press or by process of natural ripening, may cause a septum structurally complete (i. e. reaching from suture to suture) to appear incomplete; yet when the valves are more or less turgid, pods of the same species with septum equally developed may appear to be in varying degrees bilocular. While a strongly inflated or turgid pod is characteristic of a few species, the precise degree of inflation is not invariable; for example, in one small colony of *O. Lagopus* var. *atropurpurea* pods of nearly uniform length were found to vary from narrowly ellipsoid, through broadly oblong, to subglobose.

HYBRIDIZATION

Where *O. Lambertii* with purple and *O. sericea* with white to primrose-yellow flowers meet and mingle on the higher prairies and foothills of the Atlantic slope, what appear to be hybrid swarms of uncommon vigor and complexity arise, and a stand of these plants, with scarcely two alike in color, shading from white to pink, lavender, or crimson-purple, can make a marvellously brilliant picture. These conspicuous polychrome populations have done much to obscure the distinctness of the parent species which, when in pure form, can always be separated by the attachment of the pubescence. In North Dakota, *O. campestris* var. *dispar* is similarly vari-colored, and it may well have arisen in the past from crossing between *O. Lambertii,* common in the same region, and *O. campestris* var. *gracilis* immediately to the west. In the Wyoming mountains *O. campestris* var. *gracilis* and *O. sericea* come together and resultant hybrids, intermediate in size of flower and number of leaflets and thus easy to spot in the field (though very difficult to detect in the herbarium) are not infrequent. Hybrids are to be expected wherever forms of *O. campestris* and *O. viscida* overlap in range and crosses between various strains of these two polymorphic and closely allied species are known or suspected. There are indications of an *O. campestris* var. *varians* X *O. Maydelliana* hybrid in Alaska and perhaps some other puzzles in the genus will be resolved when the scope of hybridization becomes more fully understood.

ACKNOWLEDGMENTS

It is a pleasure to acknowledge the courtesy and encouragement which the writer has encountered on all sides during the preparation of this paper. A special debt is due Miss Alice Eastwood and Mr. John Thomas Howell of the California Academy of Sciences, and Dr. Bassett Maguire of the New York Botanical Garden who generously made available for leisurely study the important collections in their respective herbaria. It is on the material in these two collections, supplemented by the much smaller herbarium in the possession of H. D. Ripley and the writer, that this study is principally based. Visits to and loans from other herbaria have provided invaluable information, and grateful acknowledgment is tendered to all those who have lent or donated specimens for study. The help of Mr. N. Y. Sandwith, of the staff of the Royal Herbarium, in looking up critical types at Kew and the British Museum, is especially appreciated. I have also had the privilege of reading a mimeographed paper dealing with *Oxytropis* in the Rocky Mountains by that keen student of the genus, Professor C. L. Porter; according to my understanding the author does not regard this as properly published, and it is therefore not cited.

HERBARIA CONSULTED (with symbols, after Lanjouw, used in citation of specimens)

California Academy of Sciences, San Francisco	(CAS)
Gray Herbarium of Harvard University, Cambridge	(GH)
University of Minnesota, Minneapolis	(MINN)
Herbarium Greeneanum, Notre Dame University, South Bend	(ND)
New York Botanical Garden, New York	(NY)
Oberlin College, Oberlin, Ohio	(OB)
Philadelphia Academy of Sciences, Philadelphia	(PH)
Pomona College, Claremont	(POM)
University of Idaho, Southern Branch, Pocatello	(IDS)
Herbarium of H. D. Ripley and R. C. Barneby	(RB)[2]
Rocky Mountain Herbarium, Laramie	(WYO)
University of California, Berkeley	(UC)
United States National Museum, Washington, D. C.	(US)
University of Washington, Seattle	(WTU)
Washington State College, Pullman	(WTC)

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[2] Collections of Ripley and the writer are all represented here, and the symbol has been used only when the specimen in question has reached us from other sources.

Systematic Treatment

Key to the North American Species of Oxytropis

1. Stipules very shortly adnate to the base of the petiole; pod pendulous.................... 1. *O. deflexa*

— Stipules adnate through half their length or more (or at least through 4 mm.) to the enlarged, scarious or chartaceous bases of the petioles; pod erect or speading 2

2. Leaves simple or trifoliolate, the leaflets obscurely jointed to the rachis.................... 2. *O. Mertensiana*

— Leaves 5–plurifoliolate, the leaflets all jointed to the rachis.................... 3

3. Leaflets all scattered or opposite, none germinate or fascicled at the same point on one side of the rachis.................... 4

— Leaflets, at least on some leaves, germinate or fascicled at the same point on one side of the rachis.................... 32

4. Racemes 1–5-flowered, subcapitate at anthesis and scarcely elongating in fruit; corolla (except in rare albino individuals) purple or violet, never ochroleucous or yellow 5

— Racemes 6–many-flowered or, if occasionally less, the petals yellow, ochroleucous or white; axis of the raceme nearly always elongating in fruit.................... 17

5. Calyx campanulate, not turgid and but little accrescent in fruit, at length ruptured and investing the base of the pod, or thrust back and enveloping its stipe 6

— Calyx turgid at full anthesis, becoming inflated-accrescent, ultimately enclosing the body and often the beak of the pod, not ruptured. Pod small, rarely exceeding 1 cm. in length.................... 15

6. Plants of Arctic or subarctic distribution or, if high alpine in the Rocky Mts., then the leaflets linear, glabrate in age, the flowers large (keel 10–11 mm. long), and the pod stipitate and bladdery-inflated.................... 7

— Plants of the Rocky Mts. (Idaho to New Mexico) and westward across the Great Basin; keel (except in *O. Jonesii*, local in Utah) at most 9 mm. long; leaflets broader, densely and permanently silky-canescent or, if greenish, ovate; pod sessile or nearly so.................... 13

7. Plants eglandular; bracts pilose dorsally; calyx-teeth (except in *O. campestris* var. *terrae-novae* of Labrador and Hudson Str.) 2–4 mm. long.................... 8

— Plants glandular and viscid; bracts glabrous dorsally or nearly so; calyx-teeth 1:5 mm. long or less. Leaflets small, thick, corrugated when dry; cf. var. *hudsonica* of .... 14. *O. viscida*

8. Stipules thin and fragile, their margins beset with clavate processes mixed with bristly ciliae. Melville Peninsula to Alaska.................... 20. *O. arctica*

— Stipules firm, the margins glabrous or with bristly ciliae only.................... 9

9. Stipules castaneous in youth, becoming chocolate-brown in age; pod stipitate, oblong-ellipsoid. Alaska.................... 6. *O. kokrinensis*

— Stipules pale green, whitish or straw-colored; pod either sessile or bladdery-inflated 10

10. Pod ellipsoid to oblong-cylindroid, not more than tumid, sessile or nearly so; plants of high latitudes.................... 11

— Pod ovoid, ventricose-inflated, stipitate; coast of Labrador and in the Rocky Mts. from Alberta to s. Colorado.................... 4. *O. podocarpa*

11. Calyx-teeth 2–4 mm. long, not less than one third as long as the tube............ 12

— Calyx-teeth 1.5 mm. long or less, not more than one fourth as long as the tube; cf. var. *terrae-novae* of.. 15. *O. campestris*

12. Pod 17–35 mm. long, bilocular or nearly so, the septum at least 1.5 mm. broad; petals ample, the banner 7–12 mm., the wings 4–5 mm. wide.... 5. *O. nigrescens*

— Pod about 15 mm. long, unilocular, the septum obsolete or nearly so; petals narrower, the banner less than 7 mm., the wings less than 3 mm. wide... 3. *O. Scammaniana*

13. Pod ovoid, ventricose-inflated, the valves membrano-chartaceous..................... 14

— Pod ellipsoid, coriaceous. N. New Mexico to Wyoming, Idaho, and s.-e. California .... 9 *O. Parryi*

14. Flower small, the banner 6–12.5 mm. long; leaflets 7–17; Utah to n. Arizona and s. California.. 7. *O. oreophila*

— Flower larger, the banner 14.5–17 mm. long; leaflets 3–7; Garfield and Uintah counties, Utah.. 8. *O. Jonesii*

15. Pod chartaceous, not rigid when mature, the valves villous; septum subobsolete 16

— Pod coriaceous, rigid when mature, the valves strigose. Upper N. Platte drainage, Wyoming; cf. depauperate states of.. 17. *O. nana*

16. Bracts ovate or lance-ovate, flat above the immediate base; s.-e. Wyoming, adjacent Nebraska and Utah to Colorado.. 10. *O. multiceps*

— Bracts narrowly lanceolate, involute; n.-w. Wyoming, Montana and Idaho; cf. depauperate states of.. 11. *O. Lagopus*

17. Pubescence composed entirely of basifixed hairs... 18

— Pubescence, at least in great part, dolabriform, composed of 2-armed hairs, the descending much shorter than the ascending arm but always evident; petals usually pink-purple, rarely white or polychrome......................... 18. *O. Lambertii*

18. Stipules purplish-chestnut colored, chartaceous, the margins of the free blades beset with clavate processes mixed with bristly ciliae. High latitudes, Labrador to Alaska .... 19. *O. Maydelliana*

— Stipules pallid, whitish, greenish or straw-colored.. 19

19. Herbage, calyx, and pod more or less viscid-glandular, the calyx-teeth and pod often glandular-verrucose; bracts nearly always glabrous dorsally.. 14. *O. viscida*

— Herbage, calyx, and pod eglandular; bracts pilose dorsally................................ 20

20. Flowers small, the keel 5.5–9 mm. long; pod ventricose-inflated; plants of the Great Basin to s. California.. 7. *O. oreophila*

— Flowers larger, the keel either 1 cm. long or more, or the pod and distribution quite otherwise 21

21. Calyx becoming turgid at full anthesis, strongly inflated in fruit, wholly enclosing the body and usually the beak of the small pod.. 22

— Calyx not conspicuously accrescent in fruit, ruptured and merely investing the base of the pod.. 23

22. Pod villous, the valves membrano-chartaceous, not rigid; corolla of medium size, the keel 11–14 mm. long; n.-w. Wyoming, Montana, e. Idaho; vars. of.. 11 *O. Lagopus*

— Pod strigose, firmly chartaceous, rigid at maturity; corolla more ample, the keel 16–17 mm. long; N. Platte drainage and vicinity, Wyoming.... 17. *O. nana*

23. Corolla purple 24

— Corolla white, ochroleucous, or pale yellow, the keel sometimes purple-maculate 31

24. Stipules fragile, the margins beset with clavate processes mixed with bristly ciliae; arctic shores, Mackenzie westward; forms of........ 20. *O. arctica*

— Stipules firmer, not fragile, and lacking clavate processes; distribution otherwise 25

25. Calyx densely shaggy-villous or hispid-hirsute with spreading hairs; pod villous 26

— Calyx silky-pilose with appressed hairs, these sometimes mixed with a few longer villi, or shortly-pilosulous, but not densely shaggy or hispid........ 27

26. Vesture of the calyx densely shaggy-silky, almost or quite concealing the surface of the tube at anthesis; herbage similarly silky-villous, the scapes villous or rarely glabrate; bracts lanceolate to linear, membranous or nearly so, involute-cymbiform, shaggy-pilose dorsally; vars. of........ 11. *O. Lagopus*

— Vesture of the calyx hispid-hirsute, at anthesis not concealing the surface of the tube, and strongly contrasting with the subappressed-pilose vesture of the herbage; bracts rhombic-lanceolate, mostly herbaceous, thinly appressed-pilose, the blades plane at least in their upper two thirds; vars. of........ 12. *O. Besseyi*

27. Plants occurring in pure monochrome populations, the flowers (except for an occasional albino) of uniform purple coloring........ 28

— Plants occurring in mixed or polychrome populations in which individuals exhibit evident transitions between purple, pink, lilac and white or yellowish flowers 30

28. Eastern plants (Hudson Str. to Maine and Wisconsin); petals relatively narrow and short, the keel 9–13 mm. long; vars. of........15. *O. campestris*

— Western plants (Idaho, n. Utah and Colorado); petals larger and more ample, the keel at least 14.5 mm. long........ 29

29. Pod stipitate or, if subsessile, the leaflets 13 or less; scapes exserted beyond the leaves; centr. Idaho and n. Wyoming; vars. of........ 12. *O. Besseyi*

— Pod sessile; leaflets 13–25; scapes shorter than the longer leaves; n.-w. Colorado and adjacent Utah........ 13. *O. obnapiformis*

30. Robust, with large flowers, the keel usually 15 mm. long or more; leaflets 11–19, ample; pod coriaceous, rigid; cf. forms of........16. *O. sericea*

— More slender, smaller-flowered, the keel about 13 mm. long; leaflets 19–25, smaller; pod thinner, scarcely rigid. North Dakota; var. *dispar* of........ 15. *O. campestris*

31. Pod membrano-chartaceous, not rigid at maturity; corolla mostly small, with narrow petals, the wings not conspicuously dilated upward, about 3–4.5 mm. wide near apex (but often wider in plants of the Columbia Basin and the Coast Ranges in northern Washington); vars. of........ 15. *O. campestris*

— Pod coriaceous and rigid at maturity; corolla commonly more ample, the wings conspicuously dilated upward and at least 5 mm. wide at apex; Rocky Mts. and Great Plains (Saskatchewan to Nevada and Oklahoma), but absent from the Columbia Basin westward........ 16. *O. sericea*

32. Racemes 2–10-flowered, subumbellate at anthesis, becoming 1–2 (4) cm. long in fruit; corolla relatively large, the banner at least 18 mm., the keel at least 13 mm. long 33

— Raceme 12–35-flowered, narrowly oblong or clavate at first anthesis, becoming (3) 4–16 cm. long in fruit; corolla smaller, the banner at most 15 mm., the keel at most 11.5 mm. long.. 34

33. Leaflets 21 or more to the leaf and pseudo-verticillate throughout; region of Hudson Bay .... 21. *O. Belli*

— Leaflets 21 or less, a few only geminate in some of the leaves; an Alaskan form of .... 20. *O. arctica*

34. Herbage glandular; bracts, calyx-teeth and pod glandular-verrucose; forms of .... 14. *O. viscida*

— Herbage eglandular; verrucae absent.. 35

35. All the leaves bearing predominantly paired or whorled leaflets, solitary leaflets few or none; scapes and petioles villous-pilose with fine spreading hairs, at least at base; stipules thin and fragile; corolla purple............ 22. *O. splendens*

— Primary leaves with solitary, scattered or opposite leaflets only; scapes and peduncles ascending- or appressed-pilose; stipules firm; petals white or ochroleucous (if rarely purple cf. discussion of 14. *O. viscida)*; vars. of.. 15. *O. campestris*

1. **Oxytropis deflexa** (Pall.) DC.

Caulescent, the stems with 1–7 internodes up to 5 cm. long, flexuous, ascending from a taproot and up to 2 dm. long, or permanently acaulescent and cespitose; herbage and stems loosely villous-pilose to thinly subappressed-pilose, canescent or green, the vesture often becoming tawny when dry; stipules subherbaceous, pale green or purplish, adnate through 1.5–3 (4) mm. to the petiole, the opposite margin more or less decurrent on the stem, the free blades ovate to lanceolate or drawn out into caudate-acuminate tips, 3–15 mm. long, more or less pilose dorsally, the margins ciliate or nearly naked; leaves (1.5) 5–20 cm. long; leaflets (9) 15–41, disposed in opposite or subopposite pairs horizontally to the rachis and diminishing upward along it, ovate to lance-oblong, 3–25 mm. long, loosely pilose on both faces or nearly glabrous above; peduncles erect or ascending, (2) 4–30 cm. long; racemes 5–25-flowered, either subcapitate in flower and fruit or oblong at anthesis and early becoming lax, the axis up to 15 cm. long in fruit; bracts submembranous, linear to lance-oblong, 2–7 mm. long; flowers suberect in bud, early spreading and at length pendulous and commonly secund; calyx villous-pilose, 3–6.5 mm. long; pod pendulous, subsessile, or stipitate and the stipe up to 2 mm. long, the body oblong-ellipsoid to linear-oblong in outline, 8–18 mm. long, 3–4.5 mm. in diameter, somewhat dorsiventrally compressed, sulcate ventrally, the valves thinly chartaceous, pilosulous with pale, dark, or mixed hairs, the false septum vestigial or wanting; seeds olive- or mahogany-brown 1.2–1.8 mm. in diameter.

The American representatives of the *O. deflexa* complex are among the most difficult to align in a satisfactory taxonomic pattern. The species, in the largest sense, is widely diffused in Asia eastward from Altai, with a relict station in arctic Norway, and a treatment that is not based on collections from the whole area, the only one possible at the present, cannot be anything but provincial and tentative. Since Richardson's report (1823) of *O. deflexa* in Canada, until 1928 when Fernald discussed the group, it was rather generally held that but one species, and that conspecific with the Asiatic plant, occurred in the New World. Hooker's *O. foliolosa,* which Bunge and Gray agreed in interpreting as a stemless alpine form of *O. deflexa,* was occasionally accepted as a species apart. Fernald, who maintained *O. foliolosa,* pointed out that the cordilleran plant passing as *O. deflexa* differed in floral and calycine characters from its Asiatic analogue, and separated this as *O. retrorsa* with a small-flowered variety *sericea.* And supposedly true *O. deflexa* has lately been reported from Alaska. The characters used to distinguish these three species, *O. deflexa, O. retrorsa,* and *O. foliolosa* are few and, as I shall attempt to show, scarcely of specific value. In the following paragraphs it should be understood that the epithet "*deflexa*" is used in the narrowest, Asiatic sense.

Caulescence. Stemlessness is said to characteristic of *O. foliolosa,* developed internodes of *O. deflexa,* whereas *O. retrorsa,* normally caulescent, varies into an "acaulescent or subacaulescent," "more northern or more alpine" (Fernald, 1928, p. 140) var. *sericea.* In point of fact *O. foliolosa,* although always acaulescent in Labrador and usually so in the Rockies, may occasionally, when carried down along streams from alpine elevations, produce one or two short but evident internodes. A stemless variety of *O. deflexa* (var. *subcapitata* Trautv., Act. Hort. Petrop., 5: 38, 1877) has been described from northern Siberia. It is possible of course that this, of which I have seen no material, is actually *O. foliolosa* itself, but in any case it will be seen that the state of caulescence is not to be applied as a rigid criterion.

Length of fruiting raceme. The raceme of *O. foliolosa* is said scarcely to elongate, whereas it becomes lax and open in *O. retrorsa* and *O. deflexa.* But the length of the raceme is closely correlated with the degree of caulescence, in some robust cordilleran specimens of *O. foliolosa* attaining a length of 2.5 cm., while in some condensed examples of *O. retrorsa* it may remain less than 5 mm. long. The *O. deflexa* var. *subcapitata* was described as having the fruiting raceme subcapitate. The length of the raceme is therefore not wholly reliable.

Calyx. A broadly campanulate calyx with truncate tube and narrow teeth separated by broad, obtuse sinuses is actually characteristic of *O. deflexa* and *O. foliolosa.* In *O. retrorsa* the calyx is proportionately narrower, with lanceolate, approximate teeth separated (except on the axial side) by narrow and acute sinuses. In the latter, however, the calyx is extraordinarily variable in length and, while at their maxima the shape and disposition of the teeth are distinctive, this state is linked by a series of intermediates with a small extreme in which the tube becomes shortly campanulate, and the ventral and lateral sinuses scarcely if at all narrower than in the smallest-flowered Asiatic state of *O. deflexa.* It is difficult to draw a clear line between the Old and New World species on this basis.

Petals. The banner of *O. deflexa* and *O. foliolosa* is in each case relatively broad and the whole flower of a good purple, while that of *O. retrorsa* is narrower in proportion to its length and usually pale. Very small-flowered examples of *O. deflexa* and corresponding specimens of *O. retrorsa* are nearly identical, however, in shape of the petals, while the flower of *O. retrorsa* is occasionally highly colored.

Pod. The pod is identical in structure in all three species but that of *O. foliolosa* is supposedly shorter, according to current accounts. The pod of *O. retrorsa* has been found to vary between 10 and 18 mm. in length, that of *O. foliolosa* between 8 and 17 mm. The stipe tends to be longer in *O. foliolosa* but is not absolutely so.

Distribution. While the dispersal of a species cannot be said to be a "taxonomic character," it is often, in practice, a distinctive quality, one which may furnish invaluable evidence of the nature and history of a taxon. I cannot speak with authority of the extra-American distribution of *O. deflexa,* but in its sporadic American occurrence it appears to exist only in a few relict stations in alpine Colorado and the Yukon valley, thus having all the appearances of a species which was nearly exterminated by the Tertiary glaciations and so depauperated by them that its power to reoccupy old territory was practically exhausted. *Oxytropis foliolosa,* again alpine in the Rocky Mountains, but with scattered stations in Labrador, Gaspé, and the coast of Mackenzie, exhibits in its main area a certain variability and power to adapt itself to various sites and elevations, but is very likely an ancient immigrant from Asia, and probably poor in biotypes at the present time. By contrast *O. retrorsa,* with a nearly continuous range at middle altitudes from New Mexico to Alaska, is extremely variable, plastic in relationship to environment, and aggressively expanding. It occurs in quantity in the Rocky Mountains where it is quick to occupy newly available territory such as roadside ditches or grazed meadowland, and is rich in small variations of a type often characteristic of new (or at least not senescent) species.

Conclusions. Oxytropis deflexa differs, then, from *O. foliolosa* in that it is *usually* caulescent and more densely hairy, and in the *usually* longer racemes. The two species are precisely alike in flower and legume and can scarcely be held specifically distinct. *Oxytropis retrorsa,* which embraces a range of variation in caulescence, length of raceme, and density of vesture parallel with that found in *O. deflexa* and *O. foliolosa* combined, differs appreciably from either only in the form of the calyx and corolla. But as we have seen, the smallest-flowered forms of *O. retrorsa* and *O. deflexa* are so nearly alike even in these organs that it is possible to trace a complete sequence of variation between the extremes. *Oxytropis retrorsa* is here interpreted as the variable, aggressive, post-glacial progeny of an old, widely dispersed species which persists unchanged as a relict in a few favored stations in America. It seems not yet sufficiently modified to have acquired a true separation from the ancestral type, and is here subordinated, as var. *sericea,* to *O. deflexa.*

KEY TO THE AMERICAN VARIETIES OF O. DEFLEXA

1. Lateral sinuses of the calyx similar to the ventral, broad and obtuse; petals ample, purple, the banner broadly obcordate, about twice longer than broad 2

— Lateral sinuses similar to the dorsal pair, narrow and acute, rarely a little broader and rounded; petals narrower, commonly only bluish- or purplish-tinged, the banner oblanceolate, about three times longer than broad.............................c. var. *sericea*

2. Copiously and loosely villous-pilose; stems commonly developed, with at least one apparent internode at maturity; raceme (5) 10–20-flowered, usually elongating in fruit; alpine in Colorado; Yukon valley; Asia..........a. var. *deflexa*

— Sparingly pilose, green, the vesture usually appressed; stems usually none, but occasionally with one or two developed internodes; raceme (2) 7–10-flowered, nearly always compact in fruit..........b. var. *foliolosa*

1a. **Oxytropis deflexa** (Pall.) DC. var. **deflexa**

Oxytropis deflexa (Pall.) DC., Astrag., 33, tab. 27. 1802. *Astragalus deflexus* Pall., Act. Acad. Petrop., 2: 268, tab. XV. 1779. *Aragallus deflexus* (Pall.) A. Hell., Cat. N. Amer. Pl., 4. 1898.

Astragalus retroflexus Pall., Astrag., 33, tab. 27. 1800.

Caulescent or subacaulescent; permanently silky-pilose, the stems and petioles more or less villous with spreading or retrorse hairs; leaves 5–15 cm. long, with 25–35 leaflets; racemes 5–20-flowered, 1.5–6 (and probably more) cm. long in fruit; calyx 3–6.5 mm. long, densely pilose with some or nearly all fuscous hairs, the campanulate tube 2–3.5 mm., the teeth (usually narrowly linear) 1–3 mm. long, the ventral sinuses broad and obtuse; corolla purple, the obcordate banner 4–10.5 mm. long, 2.2–5 mm. broad; wings 4.5–9 mm. long, the blades 1–2.5 mm. broad, obtuse or obliquely truncate; keel 4–8.5 mm. long, the appendage minute or up to 1 mm. long. *Type* collected by Simon Peter Pallas, ". . . ad nivalia juga Dauriae . . . in excelsis montibus circa Balyra rivum aliosque Ononem influentibus."

Distribution: Alpine in central and southwestern Colorado; upper Yukon Valley; Siberia westward to Altai; reported from Norway (Finmark: subsp. *norwegica* Nordh.). Map 1.

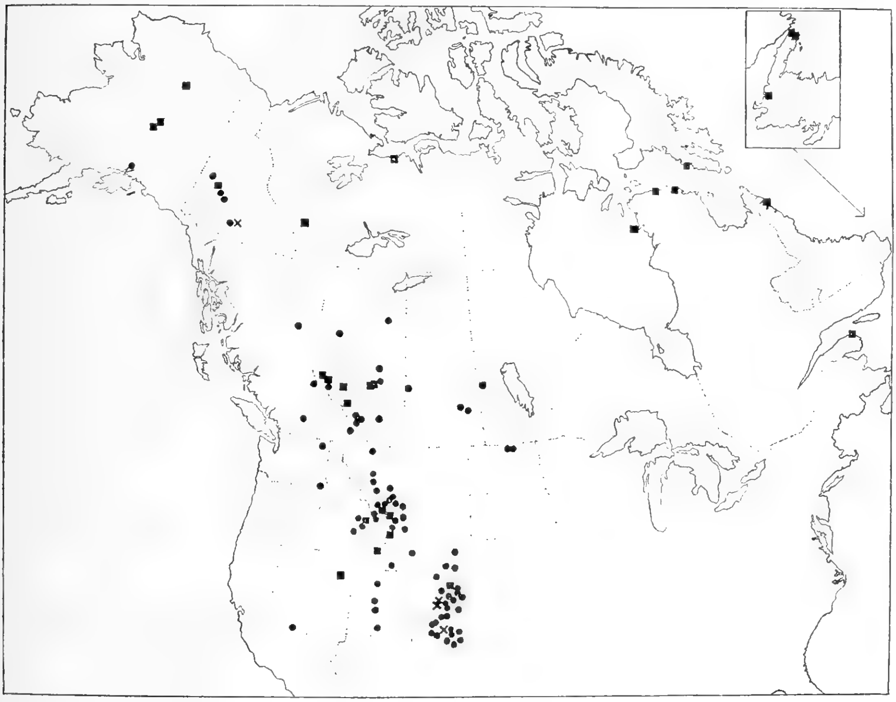
American specimens studied: YUKON. Lower Laberge, *J. P. Anderson 1774* (POM). COLORADO. Sheep Mount, *Purpus 703* (UC). East River, Gunnison County, *Coulter, Hayden's Survey in 1873* (US). Virginia Peak, n.-e. of Gothic, Gunnison County, *B. Osborn 2446* (US). Rio Grande National Forest, Mineral County, *Murdoch 4607* (CAS, NY). Sawatch Range, Pitkin (or Lake) County, *Brandegee in 1880* (NY, UC).

The Colorado plant seems to match genuine Asiatic material of *O. deflexa* at every point. A similar case of interrupted distribution is known in *Draba fladnizensis* Wulf., native (acc. C. L. Hitchc., Univ. Wash. Pub. Biol., 11: 108, 1941) to Colorado, one mountain in British Columbia, and Norway, and subsequently discovered in the Sierra Nevada, California, by Mr. Howell; so that the occurrence of var. *deflexa* in America is not without precedent. The Murdoch gathering was found in a cover (NY) labelled by Rydberg with an unpublished name. Rydberg had realized that the specimen was not exactly *O. deflexa* as then accepted.

1b. **Oxytropis deflexa** (Pall.) DC. var. **foliolosa** (Hook.) Barneby

Oxytropis deflexa (Pall.) DC. var. *foliolosa* (Hook.), Barneby, Leafl. West. Bot. 5:111. 1951. *O. foliolosa* Hook., Fl. Bor.-Amer., 1:46. 1834. *Aragallus foliolosus* "Hook." ex Macoun, Ottawa Nat., 13:163. 1899. *Astragalus deflexus* var. *foliolosus* (Hook.) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937.

Acaulescent or sometimes with one (or even two) developed internodes; vesture commonly sparse, subappressed, or with some spreading hairs on



Map 1. Range of *Oxytropis deflexa:* var. *deflexa* (in America) X; var. *foliolosa* (Newfoundland inset) ■; var. *sericea* ●.

petioles and peduncles, rarely canescent when young; leaves 1.5–12 (22) cm. long, with (9) 15–29 leaflets; racemes (2) 4–10-flowered, subcapitate in early anthesis, rarely elongating in fruit, the axis 3–30 (rarely to 80!) mm. long; calyx 6–7 mm. long, the campanulate tube 3–4. mm., the teeth 2.5–3 mm. long, the ventral and lateral sinuses broad and obtuse; corolla purple, the banner 7–10 mm. long, (3.5) 4.5–5.5 mm. broad; wings (7) 7.5–8.5 mm. long, the blades 1.5–2 mm. broad; keel 7–8.5 mm. long, the appendage 0.5 mm. long or reduced to a minute boss; stipe of the pod 1.5–2 mm. long, the body 8–17 mm. long, 3–4.5 mm. in diameter. *Type* from "Carlton House to the Rocky Mountains, in latitude 54°" (i. e. Alberta), the collector not stated.

Distribution: Alpine crests and meadows in the Rocky Mountains, from Colorado to Alaska, rarely descending along streams to the north; also on arctic and subarctic shores of Mackenzie, Ungava Peninsula, Baffin Island, Labrador, w. Newfoundland, and on Gaspé Peninsula, Quebec. Map 1.

Representative specimens: ALASKA. Wiseman, *Scamman 944* (GH). Savage River near Savage Camp, *Mexia 2031* (CAS, US). FRANKLIN. Lake Harbor, Baffin I., *Polunin 1399* (US). ALBERTA. "Rocky Mts.," *Burke* (GH, ex herb. Hook.). Fort Saskatchewan, *G. H. Turner 1342, 2465* (GH, the caulescent extreme). QUEBEC. Smith I., e. coast Hudson Bay, *Malte 120885* (GH). Anse Pleureuse, Gaspé County, *Marie-Victorin & Rolland-Germain 49426* (GH, WTC). LABRADOR. Rowsell Harbor, *Abbe & Odell 460* (GH). NEWFOUNDLAND. Cook Point, Pistolet Bay, *Fernald & Gilbert 28601* (GH). MONTANA. Koch Peak, Taylor Mts., Madison County, *Hitchcock & Muhlick 15188* (NY, RB, WTC, WTU). IDAHO. East fork Pahsimeroi River, Custer County, *Hitchcock & Muhlick 11096* (CAS, NY, WCT, WTU). WYOMING. Teton Pass Mts. e. of Victor, *E. & L. Payson 2130* (CAS, GH, NY). NEVADA. Liberty Pass, Ruby Mts., Elko County, *Munz 16225* (POM). COLORADO. Willis Gulch, Gilpin County, *Biltmore Herb. 1646* (US).

While material from the Northeast is rather uniform in detail and appearance, var. *foliolosa* is evidently more variable in the Rocky Mountains. Robust, loosely flowered examples from the lowlands in Alberta and diminutive plants from Yellowstone Park (e. g. *Tweedy 78,* NY) exhibit opposite extremes in stature, length of fruiting raceme, and length of pod. Occasionally, as in Miss Scamman's Alaskan plant, one developed internode is produced, when the variety can scarcely be distinguished from var. *deflexa* (to which the specimen was referred in Rhodora, 42:333) except by the fewer-flowered raceme and usually fewer leaflets.

It seems quite possible that *O. deflexa* var. *subcapitata* Trautv., described from plants collected in northern Siberia by Czekanowski and Mueller, may be an earlier varietal name for var. *foliolosa.* The diagnosis calls for a stemless plant with subcapitate fruiting raceme. No material of var. *foliolosa* has been seen from beyond Behring Strait, but it might well extend into

Asia. The point can be decided only by reference to the type, presumably in Leningrad.

Oxytropis foliolosa has often been likened to the Eurasian *O. lapponica* (Wahlenb.) J. Gay, the inflorescence of which is quite similar. But the stipules of *O. lapponica,* connate into a sheath opposite the petiole, are fundamentally different.

1c. **Oxytropis deflexa** (Pall.) DC. var. **sericea** T. & G.

Oxytropis deflexa (Pall.) DC. β *sericea* T. & G., Fl. N. Amer., 1:342. 1838, *sensu ampliato. O. retrorsa* Fern. var. *sericea* (T. & G.) Fern., Rhodora, 30:140. 1928.

O. retrorsa Fern., 1928, l. c.

O. deflexa var. *culminis* Jeps., Fl. Calif., 2:381. 1936.

O. deflexa sensu auct. amer. plur. (saepe sub *Aragallo); non* DC.

Usually caulescent, rarely stemless; herbage and stems loosely villous-pilose, the hairs on the stems and petioles often horizontally spreading or retrorse, the whole greenish or somewhat canescent; leaves 5–20 cm. long, with 23–41 leaflets; racemes usually 10–25-flowered, when oblong-pyramidal in bud and early becoming lax, the fruiting axis 5–13 cm. long, but rarely only 3–10-flowered, when short or even subcapitate in fruit; calyx at anthesis 4–8 mm. long, sometimes a trifle accrescent in fruit, the campanulate to narrowly turbinate tube 2–3.5 mm., the lanceolate teeth (1.5) 2–4 (5) mm. long, separated, except on the ventral side, by narrow and acute sinuses; corolla commonly pale, whitish, lilac or bluish, sometimes tipped with deep purple, the banner 4.5–9 mm. long, 2.3–3.5 mm. broad; wings 5–8 mm. long, the blades about 1 mm. broad; keel 4.3–8 mm. long, the appendage usually minute. *Type* collected by Thomas Nuttall, in 1834, in the "Rocky Mountains, near streams" (i. e. probably western Wyoming); "Ore. Ry. Mts.," *Nuttall* (NY)!

Distribution: Stream-banks, meadowland, mountain parks, often along ditches or grassy swales, rarely in dry soils, at middle and rather high altitudes in the Rocky Mountains from Alaska to northern New Mexico, westward to eastern Washington, Oregon and California, and eastward on the northern plains to Manitoba. Map 1.

Representative specimens: ALASKA. Matanuska, *J. P. Anderson 900* (US). YUKON. Carmacks, *Eastwood 573* (CAS, GH, POM, US, WTC). BRITISH COLUMBIA. Chipuin Mt., Marble Mts., *J. W. & E. Thompson 544* (US, WTU). ALBERTA. Rosebud Creek, Rosedale, *Moodie 1200* (GH, NY, US). SASKATCHEWAN. Ribstone Creek, *Macoun & Herriott 70801* (CAS, NY, POM). MANITOBA. Red Deer Lakes, *J. Macoun 454* (NY). WASHINGTON. Wauconda Summit, Okanogan County, *J. W. Thompson 7119* (GH, WTU). IDAHO. Challis, Custer County, *Macbride & Payson 3346* (CAS, POM, US). MONTANA. Warmsprings, Deer Lodge County, *Ripley & Barneby 8158*

(CAS). Boulder Canyon, Sweet Grass County, *C. L. Hitchcock 16342* (RB, WTC, WTU). OREGON. Hurricane Creek, Wallowa County, *Peck 22597* (RB). WYOMING. Leckie, Sweetwater County, *Merrill & Wilcox 774* (GH, NY). CALIFORNIA. Cottonwood Creek, White Mts., Mono County, *Duran 1650* (UC, type of *O. deflexa* var. *culminis)*. UTAH. Aquarius Plateau, Garfield County, *Maguire 19175* (GH, IDS, WTU). COLORADO. Como, Park County, *Crandall & Cowen 152* (GH, type of *O. retrorsa)*, *Crandall 116* (US). Arboles, Archuleta County, *C. F. Baker 410* (GH, NY, POM, US). NEW MEXICO. Chama, Rio Arriba County, *Earle 30* (NY).

The var. *sericea* is here extended to embrace the whole of Fernald's *O. retrorsa*. It is regrettable that the epithet "*retrorsa*," originally intended to cover nearly the same concept, cannot be conserved, but var. *sericea* has obvious priority if included in it. The original *O. deflexa β sericea* was separated upon the superficial single character of "leaves silky-villous," and the basic Nuttall specimen in the Torrey Herbarium is a young, densely pilose plant, as yet without developed internodes, with short, *dark*-hairy calyx (5.5 mm. long), its teeth separated by the acute sinuses characteristic of the common cordilleran plant, and with small, pale, narrow-petalled flower. Fernald maintained this as a variety of caulescent, larger-flowered and greener *O. retrorsa* on account of its "smaller leaves, pale (!) calyx only 3.5–5.5 mm. long, and paler corolla . . ." To test these characters 63 sheets, equably covering the range of *O. retrorsa* (NY, RB) were separated on the basis of calyx-measurements, 26 having the calyx 4–5.5 mm., and 37 the calyx 6–8 mm. long. In the first group only six were found to be acaulescent or subacaulescent (with not more than one developed internode), while there were three in the other. The calyx-hairs of the first group were in nine cases predominantly pale, in four predominantly fuscous, and in thirteen mixed in about equal proportions; in the large-calyxed group two-thirds (23) were dark-haired, eight pale, and six intermediate. Sericeous and glabrate herbage occurred in both series. Fernald, to be sure, admitted the existence of numerous intermediates, but the factors are too little correlated to be used with profit in defining a variety. At Silverton, Colorado, it was noticed that plants growing along a swale *(Ripley & Barneby 7109*, CAS) were strongly caulescent, dark-hairy on the long calyx and relatively large-flowered (with purplish banner about 9 mm. long), whereas on the drier banks nearby occurred a subacaulescent phase, with pale, shorter calyx and smaller corolla (the banner whitish and about 6 mm. long). Here the available moisture seemed to be the controlling factor.

The variety is strikingly variable in size of corolla, in length of calyx-teeth, and in development of the raceme, and it is a temptation to separate the extreme forms. Particularly remarkable are the following:

a. Plants from Alberta, British Columbia and Yukon (Banff, *McCalla 2125*, NY, US, WTU) with minute corolla, shortly campanulate calyx with rather broad lateral sinuses between the teeth, and short pod, 10–12 mm. long. These closely approach the smallest-flowered forms of var. *deflexa* from Asia, differing in the pale corolla and narrower banner. Probably this is the equivalent of the "Eastern Siberian-Alaskan type" which Hultén (Fl. Alaska & Yukon 1096) defines so as to include the relict Norwegian race of the species, material of which I have not seen.

b. Plants from Idaho and Montana (Hyndman Creek, Blaine County, *J. W. Thompson 13516,* WTU, RB; Wilsall, Park County, *Suksdorf 609,* CAS), caulescent or acaulescent but in either case slender throughout, glabrate, with filiform peduncles and 4–9-flowered racemes lax in fruit, and rather few leaflets. In the Thompson collection an occasional secondary raceme is very shortly pedunculate, with fruiting axis only 6 mm. long. In Dr. Peck's most curious gathering from the Wallowa Mts., Oregon (cited above), the racemes are all reduced to three or four flowers and remain abbreviated in fruit, the plant thereby closely simulating var. *foliolosa* in habit. But the narrow pale flowers are those of var. *sericea.*

2. **Oxytropis Mertensiana** Turcz.

Oxytropis Mertensiana Turcz., Bull. Soc. Nat. Mosc., 1840, p. 68. 1840. *Spiesia Mertensiana* (Turcz.) O. Kze., Rev. Gen., 206. 1891. *Aragallus Mertensianus* (Turcz.) Greene, Pittonia, 3:211. 1897.

Acaulescent, but the slender caudex-branches elongating and up to 11 cm. long, clothed in imbricated stipules; stipules membranous, pale, connate at base, 10–15 mm. long, glabrous dorsally, the deltoid to lance-subulate free blades 1.5–9 mm. long, sparingly bristly-ciliate; leaves (1) 2–7 cm. long, the primary 1-foliolate, reduced to a single terminal ovate, lanceolate or elliptic acute blade 8–22 (29) mm. long, 2–5 mm. broad, obscurely if at all articulate to the glabrous petiole, the secondary simple to subpalmately 3-foliolate, the leaflets all 3-nerved, glabrous below, sparingly pilose above or merely ciliate along the inrolled margins; scapes erect or ascending, 2.5–6 cm. long, equalling or surpassing the leaves, thinly villous-pilose, the hairs becoming black toward the inflorescence; racemes loosely 2–3 (4) -flowered, the flowers ascending, the axis not more than 5 mm. long in fruit; bracts linear, membranous, 3–6 mm. long, black-hirsute dorsally; calyx 5.5–8 mm. long, densely black villous-hirsute, the tube 4–5 mm., the linear-subulate teeth 1.5–3 mm. long; petals purple, the claws paler than the blades; banner obovate, emarginate, 12–14.5 mm. long; wings 9.5–11 mm. long; keel 8–10 mm. long, the claws and blade subequal, the appendage minute; pod stipitate, the stipe 1.5–2 mm. long, the body ovoid-oblong or lance-oblong, 11–15 mm. long, 4–5 mm. in diameter, passing into a short, more or less divergent beak, the valves membrano-chartaceous, pilose-hirsutulous with black hairs, the false septum rudimentary, about 0.5 mm. broad. *Type* collected by Dr. Mertens, "ad sinum Sancti Laurentii."

Distribution: Rocky ground, apparently often among moss and lichens, interior Alaska to Seward Peninsula, Cape Lisburne (fide Gray), islands of Behring Strait, and westward to the Lena River (Yakutsk Prov., Siberia). Map 2.

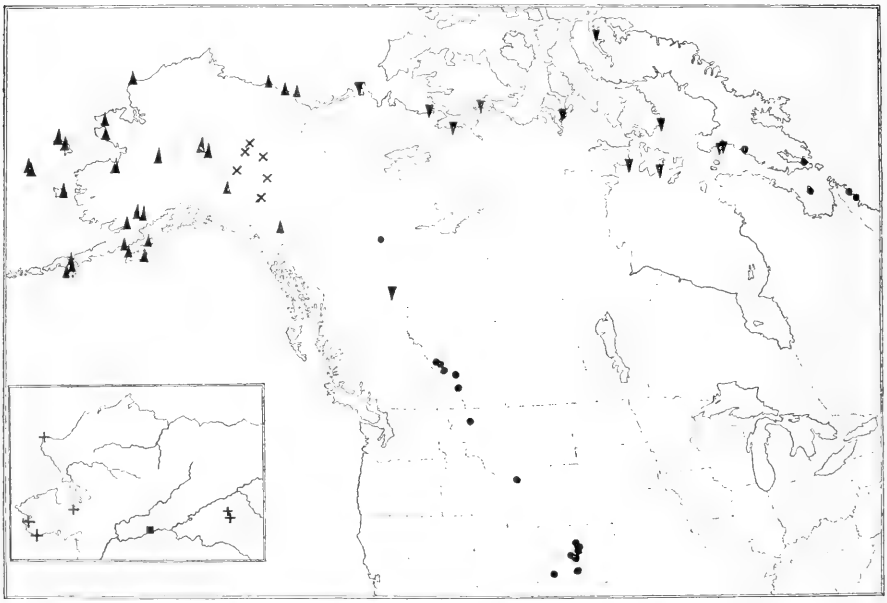
Representative American specimens: Alaska. Porcupine Dome, *Scamman 809* (GH). Upper Kougarok River, Seward Peninsula, *Atwater in 1909* (GH). Cape Nome, *Blaisdell in 1900* (GH, NY, US).

The slender habit, simple primary and trifoliolate secondary leaves, all glabrous on the lower surface, and the few-flowered, densely black-villous inflorescence readily identify this curious little species.

3. **Oxytropis Scammaniana** Hultén

Oxytropis Scammaniana Hultén, Ark. Bot., 33B:4, fig. 2, 3 (map), 1947.

Densely or more often loosely cespitose, the caudex-branches either arrested or elongating and up to 8 cm. long; herbage green, the leaflets sparingly pilose, the inflorescence copiously hirsute with black hairs; stipules pale or faintly purple-tinged, 7–13 mm. long, glabrous or nearly so dorsally, the free blades ovate to lanceolate, 1.5–6 mm. long, prominently 1-nerved, at first ciliate with white or some fuscous bristles, the cilia at length deciduous; leaves 2–6 cm. long, the slender petioles subglabrous or



Maps 2 (northwestern Alaska and middle Yukon valley, inset) and 3. Ranges of *Oxytropis Mertensiana* (in America) +; *O. kokrinensis* ■; *O. podocarpa* ●; *O. Scammaniana* X; and *O. nigrescens:* var. *nigrescens* (in America) ▲; and var. *uniflora* ▼.

with a few scattered hairs; leaflets 9–13 (19), narrowly ovate to linear-lanceolate, 2.5–9 mm. long, thinly pilose or glabrate above, ciliate; scapes 2.5–6 cm. long, erect or ascending, sparingly appressed-pilose, the hairs below the inflorescence commonly fuscous; bracts lanceolate, membranous, 2–4 mm. long, loosely black-pilose dorsally; racemes subcapitately 3–4-flowered, the axis short in fruit; calyx 5.5–7 mm. long, shaggy-pilose with dark hairs (but the vesture scarcely concealing the purplish tube), the tube 3–4.5 mm., the teeth 1.5–2.5 mm. long; corolla purple, drying violet, the claws paler than the petal-blades; banner 11–14 mm. long, broadly oblanceolate, 5.5–6.5 mm. wide below the deeply emarginate apex; wings (9) 10–11.5 mm. long, the lunate blades 7–8 mm long, 2–2.5 mm. wide near the truncate or merely oblique apex; keel 8.5–10 mm. long, the appendage commonly minute; pod sessile, oblong-ellipsoid, about 15 mm. long and 5 mm. in diameter, obtuse at base and passing abruptly upward into a short deltoid beak, sulcate ventrally, the membranous valves pilosulous with black hairs, the septum from the ventral suture very narrow or obsolete; seeds brown, 1.2–1.8 mm. long. *Type* collected by Edith Scamman, at Eagle Summit, Alaska; *Scamman 806* (GH, isotype)!

Distribution: Stony hillsides in the mountains of east-central Alaska and adjacent Yukon. Map 3.

Representative specimens: ALASKA. Eagle Summit, *Scamman 2212* (GH, US). Seward Creek near Eagle, *Osgood in 1903* (US). Porcupine Dome, *Scamman 807* (GH). YUKON. White River, 61° 50′ N., *Cairnes 85865* (NY). Near Glacier, *Margaret Milvain in 1914* (CAS).

Although at first confused with *O. arctica* (Rhodora, 42:332, 1940), very different in its fragile stipules and dense silky vesture, *O. Scammaniana* belongs to quite another group of species, and when in flower only most closely resembles the more glabrous states of *O. nigrescens,* differing however in the narrower petals. As the fruit matures, the short and essentially unilocular pod is characteristic. The inflorescence and pod are similar to those of *O. Mertensiana,* which is probably its nearest American relative.

A specimen from "Juneau" *(ex herb. Kofoid.,* OB) is perhaps wrongly labelled as to locality. Until the record can be confirmed this station must be looked on with suspicion, in view of the known distribution of the species. It is omitted from the map.

4. **Oxytropis podocarpa** Gray

Oxytropis podocarpa Gray, Proc. Amer. Acad., 6:234. 1864. *Spiesia podocarpa* (Gray) O. Kze., Rev. Gen., 206. 1891. *Aragallus podocarpus* (Gray) A. Nels., Coult. & Nels., New Man., 294. 1909. *Astragalus septentrionalis* Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937.

O. arctica δ inflata Hook., Fl. Bor.-Amer., 1:146. 1834. *Spiesia inflata* (Hook.) Britt., Mem. Torr. Club, 5:201. 1894. *Aragallus inflatus* (Hook.) A. Nels., Erythea, 7:59. 1899. *Oxytropis inflata* (Hook.) Steffen, Beih. Bot. Centralbl., 58B:162. 1938, nomen (without citation).

Astragalus biflorus Schwein. ex Gray, Proc. Amer. Acad., 6:234. 1864, in syn.
Oxytropis Hallii Bge., Gen. Oxytr. 162. 1874. *Aragallus Hallii* (Bge.) Rydb., Bull. Torr. Club 33:144. 1906.

Densely cespitose, or the slender divisions of the caudex sometimes elongating and up to 3 cm. long, beset with a thatch of persistent stipules or leaf-bases; herbage pilose-hispidulous with loosely appressed or at first divergent hairs, in youth or sometimes permanently canescent, but commonly becoming greenish at maturity; stipules 6–10 mm. long, sparingly hirsute dorsally to glabrate, the ovate-deltoid to lanceolate free blades 1.5–6 mm. long, bristly-ciliate along the margins, or only at apex, or the cilia at length deciduous; leaves ascending and spreading, 0.5–4 (6) cm. long, the slender petioles densely to sparsely pilose-hirsutulous, rarely glabrate; leaflets (5) 9–13, crowded on a rachis 1–7 (10) mm. long, linear-lanceolate or linear, commonly involute and falcate, the surfaces usually sparingly hirsute and greenish, the margins more copiously so; scapes divergent, or erect at early anthesis, 0.5–4 (5) cm. long, sparingly pilose; racemes subcapitately 1–3-flowered, the flowers spreading on slender pedicels 1.5–2 mm. long; bracts ovate to lanceolate, acute or short-acuminate, hispidulous to subglabrous dorsally, ciliate; calyx 7–10 mm. long, thinly shaggy-pilose, commonly with a mixture of short dark and longer pale hairs (but either sort predominating or almost lacking), the vesture rarely concealing the surface of the tube, the latter campanulate, often narrowed into an obconic base, 5–7 mm. long, the obtusish, deltoid-lanceolate teeth (1) 2–2.5 (3) mm. long; corolla purple; banner 13–15 (17) mm. long, abruptly expanded above the claw into a suborbicular-obcordate blade 7–8 mm. wide; wings 11–13 mm. long, the blades 7–8 mm. long, somewhat dilated upward and about 3.5 mm. wide near apex; keel 10–11 mm. long, the blades about 5 mm. long, the appendage reduced to a minute boss; pod stipitate, the stipe 1.5–3 mm. long, the body ovoid-ellipsoid, bladdery-inflated, 1.5–2.5 (3) cm. long, 5–8 (when pressed, to 15) mm. in diameter, somewhat obcompressed, abruptly narrowed above into a conic-acuminate beak 3–6 (8) mm. long, the valves thinly chartaceous, strigose-pilosulous with short light or dark hairs, the false septum 1 mm. wide or less; seeds mahogany-brown, 2.2–2.5 mm. in diameter. *Type,* as originally stated, from "Labrador, Arctic regions and Rocky Mountains, lat. 49°," but by elimination of extraneous elements, Labrador and Alberta, collected by Schweinitz and Bourgeau, respectively: "*Astragalus biflorus* ex herb. Schweinitz." (GH); Rocky Mts., *Bourgeau* (GH)!

Distribution: Exposed rocky ridges and turfy hillsides above timberline in the Rocky Mountains, from Colorado to Alberta, and perhaps northward into southwestern Mackenzie; also on the coasts of Labrador, Hudson Strait, and Baffin Island. Map 3.

Representative specimens: Without locality, "*O. arctica* comm. Hooker" (GH, NY, presumed authentic *O. arctica* var. *inflata*). FRANKLIN. Frobisher

Bay, Baffin I., *Sewall 260* (GH). Labrador. Hebron to Nachvak, *Delabarre 49* (GH). Alberta. Pipestone Pass, *Macoun 65067* (GH, NY, US). Montana. Yellow Mt., Teton County, *R. S. Williams 1086* (NY). Wyoming. Yount's Peak, Park County, *Tweedy 261a* (NY). Colorado. Rocky Mts., lat. 39°–41°, *Hall & Harbour in 1862* (GH, NY, US, isotypes of *O. Hallii*[3]). Mosquito Pass, e. of Leadville, Lake County, *Ripley & Barneby 10030* (CAS, GH, WYO). Handies Peak, Hinsdale County, *Penland 1531* (CAS).

Oxytropis podocarpa, although unmistakable when bearing its bladdery, stipitate pod, is closely related to typical *O. nigrescens,* and before the fruit has formed the two species are not easy to distinguish. The vesture of both may be copiously hirsute (as in the type of *O. Hallii* and in most material of var. *nigrescens* from Behring Strait), but in nearly all cases it becomes thinner and more appressed in age, and may be so from the first. Both species occur in relatively condensed and giant phases, the large and small extremes in the present species—*O. Hallii* and *O. podocarpa* sensu stricto as defined by Fernald, Rhodora, 30: 155—being duplicated in typical *O. nigrescens* and its dwarf state known as *O. pygmaea.* The stipules tend to be longer, with narrower and more drawn-out free blades, in the loose or large aspect of each species; but there is much variation in the development of these structures and both types of stipule can be found in the same collection. Fernald claimed that *O. Hallii,* in addition to a coarser habit and longer stipule-blades, differed from *O. podocarpa* in its "more numerous and coarser leaflets, and capsules firmer, less stipitate and larger" (l. c.). Much of the most condensed material from the Alberta Rockies referable in these terms to *O. podocarpa* agrees with the type of *O. Hallii* in having 13 leaflets 5 mm. long or less. No correlation exists either between size and texture of the pod, or between size of pod and length of stipe, but rather a complete sequence of variation, such as is characteristic of many a species of *Oxytropis, O. Hallii* in this case representing the more robust end. Rydberg's attempt to maintain *O. Hallii* as distinct on the basis of "densely canescent" leaflets (Fl. Rocky Mts., in the key) is entirely at variance with a natural classification.

The difficulty in separating *O. nigrescens* and *O. podocarpa,* referred to above, exists in practice only in Alaska, where both species have been thought to occur. In 1884 Gray doubtfully referred to *O. podocarpa* some flowering plants from the Shumagin and Chiachi islands *(Harrington in 1872, Dall in 1874,* respectively, GH), and these were accepted without question by Fernald; but until undoubted fruits of *O. podocarpa* can be secured from this area there is no reason to suppose that the specimens cited, and others like them from Kodiak, are not forms of *O. nigrescens* var. *nigrescens.* In fact Hultén (Fl. Aleut. Is., 234; Fl. Alaska & Yukon,

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[3] Bunge gave the type locality of *O. Hallii* as "Athens, Illinois," copied from the postal address which appears on some Hall and Harbour labels.

1104) has firmly rejected *O. podocarpa* from the extreme Northwest, though it is questionable whether the differences in pubescence of the stipules emphasized by him are reliable criteria.

Commenting on Gray's publication of *O. podocarpa,* Fernald pointed out that the Arctic distribution, as originally stated, is probably erroneous although he had not seen the specimens on which Gray's statement was based. Certainly the "*O. campestris,* Parry" in the Torrey Herbarium, mentioned by Gray, is *O. nigrescens* var. *uniflora.* The "*O. arctica* of Richardson" (NY), in young flower, looks like an unusually silky example of *O. podocarpa* but neither its origin nor its identity is certain. In any case these doubtful records were omitted from Gray's second revision (1884, after he had seen the Kew collections), and *O. podocarpa* can be excluded with some confidence from "Arctic America."

In the same paper Fernald chose the little plant from Labrador, *Astragalus biflorus* of Schweinitz, listed first by Gray, as the type of *O. podocarpa,* and transferred the Bourgeau gathering to *O. Hallii.* Bourgeau's plant was, however, the only fruiting specimen (except perhaps the type of *O. arctica* var. *inflata* Hook., which Gray did not claim to have seen) available at the time, and almost certainly furnished the basic evidence on which Gray defined *O. podocarpa* as a species distinct from *O. arctica.* To those who can see in *O. Hallii* nothing more than a luxuriant phase of *O. podocarpa* the question of typification will be academic; but it seems unjust in any case to divorce Gray's binomial from the species to which Bourgeau's plant belongs, since this is the specimen from which the critical characters, not to mention the epithet of *O. podocarpa* were so largely drawn. The Bourgeau and Schweinitz plants are here taken as cotypical and admirably illustrative of their species.

5. **Oxytropis nigrescens** (Pall.) Fisch.

Loosely matted, cespitose, or pulvinate, the caudex-branches clothed in imbricated stipules and leaf-bases, either very short, or developed and up to 8 cm. long; vesture of the herbage sparsely and loosely pilose to densely silky-villous, the hairs shining and commonly sinuous; stipules firmly membranous at maturity, pale 5–15 mm. long, more or less pilose dorsally when young, commonly glabrate or even glabrous in age, the free blades deltoid-ovate to long-acuminate, prominently 1-nerved; leaves 0.5–4 (6) cm. long; leaflets 5–15, ovate to linear-elliptic, acute or obtuse, less than 1 cm. long, commonly crowded; scapes almost none to 4 cm. long, erect and ascending; racemes subumbellately 1–4 (usually 1 or 2) -flowered, the flowers spreading; calyx shaggy-hirsute, usually with black hairs, the broadly campanulate tube 3–6 mm., the lanceolate teeth 2–4 mm. long; corolla bright purple, drying violet, exceptionally white; banner 14–20 mm.

long, the blade suborbicular-obcordate, 7–12 mm. wide; wings 11–16 mm. long, the blades somewhat dilated upward and 4–5 mm. wide near the emarginate apex; keel 10–13 mm. long, the appendage less than 1 mm. long; pod spreading, subsessile, the stipe, when perceptible, not more than 0.5 mm. long, the body narrowly oblong-ellipsoid, acuminate or abruptly narrowed at both ends, 1.7–3.8 cm. long, 4–8 mm. in diameter, nearly terete except for the deep ventral sulcus, the valves chartaceous, shortly pilosulous to densely villous with curly, mixed pale and dark or largely dark hairs, the false septum produced so as to traverse the width of the cavity, 1.5–3 mm. wide; seeds dark brown, light brown or ''black,'' 2–2.2 mm. in diameter.

KEY TO THE VARIETIES OF O. NIGRESCENS

1. Herbage loosely hirsute or pilose, the vesture early becoming, or from the first, thin, and the herbage greenish at maturity; plants densely cespitose to loosely matted, the branches of the caudex often elongating; leaflets (5) 9–15; coastal from Yukon at longtitude 138° to Alaska and Siberia................ a. var. *nigrescens*

— Herbage densely and permanently silky-canescent; plants very densely cespitose or pulvinate; leaflets 5–11; coastal from Baffin I. to Mackenzie at about longtitude 120°, and montane in northern British Columbia...... b. var. *uniflora*

5a. **Oxytropis nigrescens** (Pall.) Fisch. var. **nigrescens**

Oxytropis nigrescens (Pall.) Fisch. ex DC., Prod., 2:278. 1825. *Astragalus nigrescens* Pall., Astrag., 65, tab. 53. 1800. *Spiesia nigrescens* (Pall.) O. Kze., Rev. Gen., 206. 1891. *Oxytropis nigrescens* fma. *genuina* Kjellm., Vega-Exped. Vetensk. Arb., 16. 1883, nomen.

Astragalus pygmaeus Pall., Astrag., 66, tab. 54. 1800. *Oxytropis nigrescens* var. *pygmaea* (Pall.) Cham., Linnaea, 6:546. 1831. *O. pygmaea* (Pall.) Fern., Rhodora, 30:153. 1928. *O. nigrescens* subsp. *pygmaea* (Pall.) Hult., Fl. Alaska & Yukon, 1103, map 833a. 1947.

Aragallus bryophilus Greene, Proc. Biol. Soc. Wash., 18:17. 1905. *Oxytropis nigrescens* subsp. *bryophila* (Greene) Hult., Fl. Alaska & Yukon 1102, map 833. 1947.

Densely cespitose to loosely matted, the caudex-branches 1–8 cm. long, clothed with a thatch of (sometimes quite loosely) imbricated stipules; herbage hirsute with shining hairs, sometimes densely so in youth, or the vesture sparser, ascending rather than spreading, and then greenish; stipules 4–15 mm. long, at first sparingly pilose and ciliate distally, the broadly ovate to lance-acuminate free blades obtuse or acute, 1.5–8 mm. long, at length glabrous, straw-colored and shining; leaves (0.5) 1–4 (6) cm. long; leaflets (5) 7–15, commonly crowded on the rachis, oblanceolate to lanceolate or linear-elliptic, 1.5–7 (10) mm. long, both surfaces equally hirsute or the upper glabrous and only the margins bristly-ciliate; scapes 1–4 cm. long; racemes 1–4 (rarely 5, commonly 2) -flowered; calyx (5) 8–10 mm. long, the tube (3) 4.5–5.5 (6) mm., the teeth 2–4 mm. long; banner

12.5–20 mm. long, 7–12 mm. broad; keel 10–13 mm. long. *Type* collected by D. D. Merk, "inter Aldanum fl[umen] et orientalem Oceanum," i. e. eastern Siberia.

Distribution: Rocky ledges, often among lichen and mosses, Arctic shores and islands from coastal Yukon to Behring Strait, south to Shumagin and Kodiak islands, and montane in interior Yukon and Alaska; westward in Siberia at least to the Lena River, Yakutsk Prov., and south to Kamtchatka Peninsula and the Kurile Islands. Map 3.

Representative American specimens: ALASKA. St. Lawrence I., *Chamisso* (GH, fragment), *Mason 6105* (CAS, GH, NY). St. Matthew I., *Macoun 18510* (ND, type of *Aragallus bryophilus).* Teller Reindeer Station near Port Clarence, *Walpole 1861* (US). Kokrines, *W. B. Miller 1604* (US). Polychrome Pass, *A. & R. Nelson 3811* (GH, NY, US, WTC, WTU). Lake Iliamna Region, *Gorman 248* (NY). Kodiak I., *Piper 4449* (US, WTC), *Loof & Loof 292* (NY, fl. white). YUKON. Demarcation Point, *F. Johansen 98179* (NY). Herschell I., *Lindstrom in 1908* (NY). Lake Bennett, near summit of "Pinnacle," *Tarleton 10* (NY, US).

Following a pattern familiar in the genus, *O. nigrescens* varies greatly in stature, size of corolla, density of pubescence, and length of stipule. The larger and more loosely cespitose state corresponds well with Pallas's plate of *Astragalus nigrescens,* the smaller with that of *A. pygmaeus.* Chamisso, reporting both from St. Lawrence Island, subordinated *A. pygmaeus* as a variety of the other, pointing out that it differed principally in being more condensed—"habitu contractiori densiores offert caespites pulvinatos"; and he expressed doubt as to a difference in the pods as indicated by Pallas. Gray and Bunge went further, reducing *A. pygmaeus* entirely; and there the matter rested until 1928 when Fernald revived *O. pygmaea* as a species. More recently Hultén (Fl. Alaska, l. c.) has restricted typical *O. nigrescens* to northeastern Asia and established for the analogous American plant a subsp. *bryophila,* distinguished by less elongated caudex-branches rising from a central taproot and clothed with firmer, less pubescent, but more strongly persistent stipules. While I have not seen sufficient or sufficiently complete Asiatic material of *O. nigrescens* for analysis of variation in the species to the west of Behring Sea, it seems highly improbable that the typical race of the species should so far depart from the rule in the genus at large as to lack, as claimed, a "distinct conical central root." When the caudex-branches are elongated, as happens occasionally even in Alaska, the root of the plant is often not collected, and in this condition also the stipules and persistent leaf-bases are more exposed to weathering and therefore disintegrate more readily. The distinction between stipules dorsally pubescent when young and afterward glabrous (as given for subsp. *bryophila)* and "new stipules, and often the old ones . . . usually conspicuously brownish- or black-hairy" is not an especially firm one, or if significant we have by definition typical *O. nigrescens* in interior Alaska, and the supposed geographic segregation fails. No doubt definite trends in one or more directions can be made out from study of a large body of material, but in this case the criteria put forward seem too slight and too casual in their geographic occurrence to support convincing taxa above the rank of forma.

The characters emphasized by Fernald for *O. pygmaea,* lately upheld by Hultén as a further subspecies of *O. nigrescens,* were the subpulvinate habit and the stipules with ''short deltoid and obtuse tips . . . at first white-ciliate but soon . . . glabrate,'' and it was suggested that *O. nigrescens* proper, with ''conspicuously attenuate narrowly lanceolate and black-hairy stipule-tips,'' originating in Asia about ten degrees south and far west of the pulvinate arctic plant, could scarcely be conspecific. However we have loosely cespitose plants with attenuate stipules not only from St. Lawrence Island (whence typical *O. nigrescens* was reported by DeCandolle as early as 1825, by Kjellman, and others), but also from Kodiak, and from the Alaska Range in the interior. In some of these the stipules are purely white-hairy, in others there is an admixture of black hairs, and the latter cannot by any detail be separated from Siberian material. No further character can be found correlated with the length of stipules or with stature, and none has ever been made out in the flower or, since Pallas, in the fruit. According to Hultén's maps, the *pygmaea* phase is more northern and interior in Alaska, a fact no doubt connected with a more rigorous climate. Pallas, erroneously describing the pods of *A. nigrescens* and *A. pygmaea* as unilocular (although his figure of the latter clearly and correctly depicts a false septum traversing the width of the pod), stated that his two species differed, in a manner not precisely stated, in the legume. Nothing of significance has been found in the few fruiting specimens examined. Canescently hirsute and glabrescent foliage occur in both the loose and the pulvinate extremes of the species (cf. *G. N. Jones 9134, 9136,* from Nome, CAS), and the flower varies within the same limits in both. There is small advantage in maintaining the more condensed state on the arbitrary basis of stipule-length when intergradation into the loosely matted aspect is continuous and complete. I can see in *O. nigrescens, O. pygmaea,* and *A. bryophilus* no more than a single, superficially variable entity.

5b. **Oxytropis nigrescens** (Pall.) Fisch. var. **uniflora** (Hook.) Barneby

Oxytropis nigrescens (Pall.) Fisch. var. *uniflora* (Hook.), comb. nov. *O. arctica β uniflora* Hook., Parry's Second Voy., Append., 4:396. 1825.

O. arctica, varietas notabilis, R. Br., Chlor. Melvill., 254. 1823.

Oxytropis arctobia Bge., Gen. Oxytr. 114. 1874, exclus. syn. *O. nigrescens* var. *arctobia* (Bge.) Gray, Proc. Amer. Acad., 20:3. 1884. *Spiesia arctobia* (Bge.) O. Kze., Rev. Gen., 205. 1891. *Astragalus nigrescens* var. *arctobia* (Bge.) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937.

O. arctobia var. *hyperarctica* Polunin, Bot. Canad. E. Arct., 293, Pl. 8. 1940.

Densely cespitose or pulvinate, the caudex-branches often becoming columnar from their dense thatch of marcescent stipules and leaf-bases; herbage densely and permanently silky-villous with subappressed and ascending hairs; stipules 4–9 mm. long, the deltoid to ovate free blades 1–3 mm. long, often glabrate in age; leaves 0.6–2 (3) cm. long; leaflets 5–9 (11), crowded, not more than 5 mm. long; scapes 3–21 mm. long; racemes 1–2-flowered; calyx 6.5–8 mm. long, densely shaggy-villous with predominantly black hairs, the tube 4.5–6 mm., the teeth 2–3 mm. long; corolla bright purple; banner 14–16 mm. long, the suborbicular blade 8–11.5 mm. broad; keel 10–11.5 mm. long; pod 1.7–3 cm. long, 6–8 mm. in diameter; seeds ochre or reddish-brown, perhaps sometimes black. *Type* collected on Parry's Second Voyage, at Barrow River (i. e. on the east coast of Melville Peninsula, lat. 67° 21′ N.); *"O. arctica β,* comm. Hook," (GH); *Parry,* comm. Greville in 1824 (NY); *"O. campestris, Parry,"* comm. Hook. (NY), at least the first two probable isotypes!

Distribution: Arctic and subarctic shores, from Baffin Island to Mackenzie, and apparently also in the Rocky Mountains of northern British Columbia. Map 3.

Representative collections: FRANKLIN. Gjöa Harbor, King William Land, *Lindström in 1904* (NY). Cape Dorset, Baffin I., *Soper 744* (GH). Arctic Bay, *Polunin 2583* (GH, isotype of var. *hyperarctica).* MACKENZIE. Lelty Harbor, *Dutilly 392* (GH). Bernard Harbor, *Johansen 294* (GH, NY). KEEWATIN. Coral Harbor, Southampton I., *Malte 119782* (GH). BRITISH COLUMBIA. Mt. Selwyn, 56° 1′ N., *Raup & Abbe 3907* (GH, NY), *3770* (NY).

Bunge's opinion that *O. arctobia* was *"O. nigrescenti* proxime affinis" has never been questioned and Gray, when he came to reduce it to varietal status, commented that it "evidently passes into *O. nigrescens."* However Fernald (Rhodora, 30: 152, 1928) maintained it as a species distinct from *O. pygmaea* (to which he then referred all western arctic American material of the *nigrescens* alliance) by reason of its broader stipule-blades, more dense and silky vesture, and relatively shorter calyx-teeth. We now have glabrescent *"O. pygmaea"* with short, broadly ovate blades to the stipules, and the length of the calyx-teeth fails to separate the more silvery eastern and glabrescent or hirsute western plants. There is no feature of the flower or pod unique to either. The similarities between *O. arctobia* and *O. nigrescens* are fundamental, while the differences in stature and vesture are relatively minor. The subordination of *O. arctobia,* advocated by Hultén (who considered it in Flora of Alaska and Yukon no more than a silky-villous race) seems to express the relationship admirably.

Apart from its outlying station in the northern Rockies, the variety has a natural and probably continuous range from Baffin Island westward to about longitude 124°. In the main area the plants are densely pulvinate, only rarely becoming a little looser in habit, as shown by Malte's gathering from Southampton Island. The material from Mt. Selwyn in British Columbia is decidedly larger in its vegetative parts, more loosely cespitose, and combines the silvery vesture characteristic of var. *uniflora* with the habit of var. *nigrescens.* The flowers, too, are exceptionally ample, and the calyx-teeth uncommonly broad. Fruiting material may perhaps reveal a distinct entity.

The var. *hyperarctica,* said to be distinguished by the glabrous inner surface of the broader pod-valves and by the paler, light-brown seeds, hardly differs significantly from the prevailing form of var. *uniflora.* In many species of *Oxytropis* the cavity of the fresh legume is traversed by filaments which dry out at maturity, and fall away at length, sometimes attached to the seeds. There are definite traces of such filaments in the isotype of var. *hyperarctica* cited, a plant collected in a condition of advanced fruit. The seeds of var. *uniflora* are commonly reddish-brown rather than "black," and the slightly paler tint in var. *hyperarctica* seems doubtfully important. The valves of the pod are about 7 mm. broad when laid out in dehiscence, in fact of about average size for var. *uniflora.*

The variety was first indicated, as an unnamed form of *O. arctica,* in Chloris Melvilleana, and has been supposed by inference to occur on Melville Island. Brown's description was added to the account of *O. arctica* as an addendum and was probably based on material secured on Parry's Second Voyage (cf. discussion of *O. arctica).* Hooker, referring back to Brown's diagnosis, merely supplied a formal name and four words of description. There can be little doubt what either had in mind. In the Gray and Torrey herbaria there are several examples distributed by Hooker himself as "*O. arctica β,* Parry," and these have been taken as authentic for the variety, even though none bears data of locality. *Oxytropis arctobia* was based on another specimen sent by Hooker under the label of *O. arctica β* to Fischer. It is unquestionably an exact synonym of var. *uniflora.*

6. **Oxytropis kokrinensis** Porsild

Oxytropis kokrinensis **Porsild, Rhodora, 41:251, tab. 553. 1939.**

Subpulvinate, the densely cespitose caudex-branches up to 3 cm. long, thickly beset with a thatch of imbricated stipules and persistent petioles; vesture of the herbage loosely silky-pilose, the hairs shining; stipules firm, 4–6 mm. long, castaneous becoming purplish-brown, at first sparingly pilose dorsally but early glabrate, the free blades deltoid, 1.2–2.5 mm. long, prominently 1-nerved, the margins bristly-ciliate; leaves 1–3 (5) cm. long, with slender, wiry petioles; leaflets 7–9, lance-ovate, conduplicate or with elevated margins, 2–7 mm. long; scapes shorter than the leaves, mostly 2-flowered; calyx thinly villous-hirsute, the campanulate tube 4–4.5 mm., the lanceolate teeth about 2.5 mm. long; corolla "purple, 1–1.5 cm. long" (ex char.); pod stipitate, the stipe about equalling the calyx-tube, the body oblong-ellipsoid, acute at both ends, slightly arched downward, 2–2.5 cm. long, 6–8 mm. in diameter, the valves papery, shortly pilosulous, the false septum produced across the width of the cavity, about 3 mm. broad. *Type* collected by A. E. and R. T. Porsild, in 1926, in the "Kokrines Mountains, divide toward Melotzina River, Alaska."

Distribution: Known only from the region of the type-collection. Map 2.

Collections examined: "Kokrinus," *W. B. Miller 1608* (US).

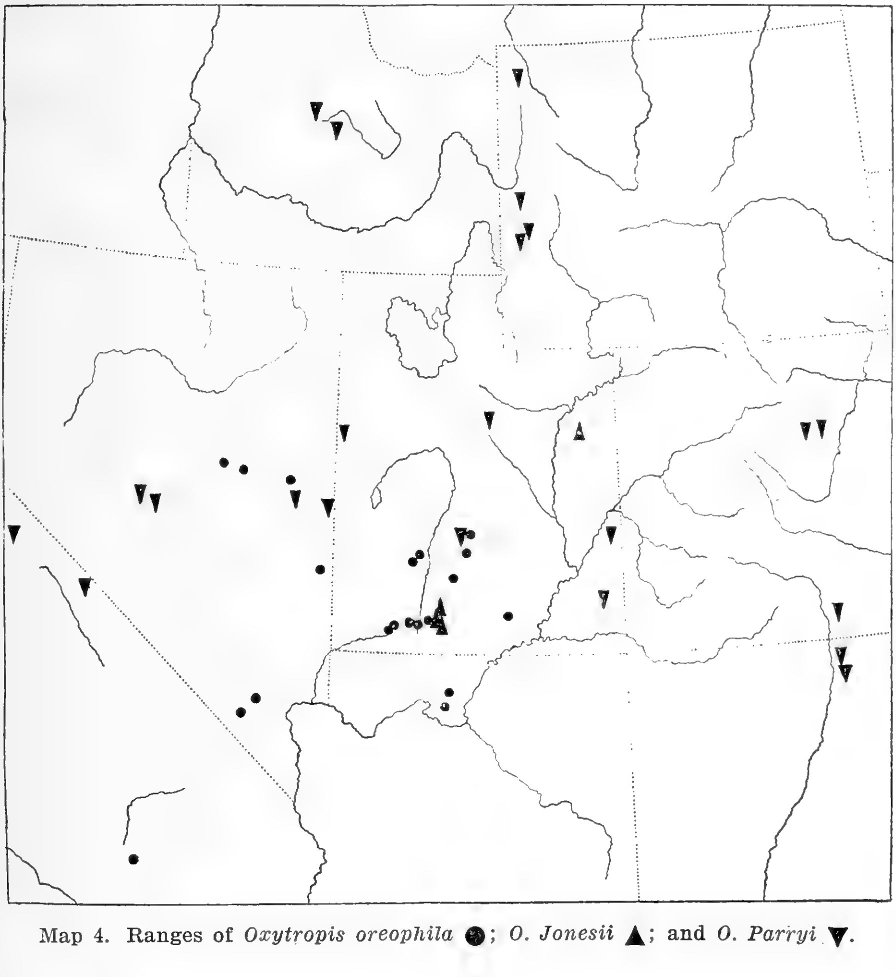
Neither of the Porsilds' collections *(no. 762,* type, *no. 761)* has been seen and the description here is based principally on the fruiting plant cited, which was also referred to *O. kokrinensis* by Hultén (cf. Fl. Alaska & Yukon, 1099, map 829, 1947). The species is amply distinguished from *O. nigrescens* by its stipitate pod, from *O. podocarpa* by its oblong, merely turgid and not bladdery-inflated pod, and from all our boreal species with few-flowered racemes by its chestnut-purple stipules.

The Kamtchatkan *O. rubricaudex* Hult. (Fl. Kamt., 3:110, fig. 14 a, b, Pl. 2, fig. e, f, 1929) which has similarly colored stipules, differs among other things in the glandular-margined stipules, leaves with 17–21 leaflets, and sessile pod only about 1.5 cm. long.

7. **Oxytropis oreophila** Gray

Oxytropis oreophila Gray, Proc. Amer. Acad., 20:3. 1884. *Spiesia oreophila* (Gray) O. Kze., Rev. Gen., 206. 1891. *Aragallus oreophilus* (Gray) A. Nels., Erythea, 7:59. 1899. *Astragalus oreophilus* (Gray) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937; non Reiche (1897), nec. Rydb. (1904). *Astragalus Munzii* Wheeler, Leafl. West. Bot., 2:209. 1939.

Cespitose or pulvinate, mature plants consisting of half a dozen to more than a hundred crowns, the caudex then becoming intricate and woody, supporting dense cushions 1–3 dm. in diameter; herbage densely silky-pilose, the hairs appressed and loosely ascending, sometimes sparsely pilose and greenish; stipules scarious, 4–12 mm. long, silky-pilose dorsally but commonly glabrate in age, especially distally, the free blades 1–5 mm. long; leaves 1–8.5 cm. long, erect or spreading (in more compact forms densely resulate, and the petioles marcescent as a thatch on the lengthening caudex-branches), with 7–17 lanceolate, elliptic, rarely ovate, acutish or obtuse, commonly conduplicate leaflets 3–9 (12) mm. long, equally pilose on both faces, when large thinly so and greenish; scapes erect, sigmoid-ascending or prostrate, 0.5–12 cm. long, much shorter than, equalling or far surpassing the leaves, sparingly ascending-pilose to copiously hirsute; racemes subcapitately 2–12-flowered, the axis scarcely elongating, not more than 1 cm. long in fruit; bracts lanceolate to linear-lanceolate, 2.5–8 mm. long, pilose dorsally; flowers spreading-ascending on slender, at length disarticulating pedicels 0.5–2.5 mm. long; calyx campanulate 4.5–7.5 (8) mm. long, villous-hirsute with shorter dark and longer pale hairs in varying proportions, the tube (3.2) 4–5.5 mm., the linear-subulate teeth (1.3) 1.8–2.5 mm. long; corolla pink or purple, exceptionally white, drying bluish; banner obovate 8–12.5 mm. long, 4–7.5 mm. broad; wings 7–10.5 mm. long, the obliquely oblong-oblanceolate blades 5–7 mm. long, little dilated upward, 1.5–3 mm. broad near the truncate or obscurely emarginate apex; keel 5.5–9 mm. long, the straight or recurved appendage 0.5–1 mm. long; pod sessile or nearly so, bladdery-inflated, 9–17 mm. long, the suborbicular to ovoid, slightly obcompressed, ventrally sulcate body passing gradually or abruptly into a deltoid or acuminate, nearly straight or strongly declined, laterally compressed beak 1.5–5 mm. long, the valves membrano-chartaceous, hirsutulous to densely villous with pale (and often also some shorter fuscous) hairs 1–2 mm. long, inflexed along the ventral suture to form a narrow false



Map 4. Ranges of *Oxytropis oreophila* ●; *O. Jonesii* ▲; and *O. Parryi* ▼.

septum 0.3–1 mm. wide; seeds brown, 1.6–1.8 mm. in diameter. *Type* collected by L. F. Ward, in 1875, in the "mountains of Utah (Aquarius Plateau at nearly 10,000 feet)"; Aquarius Plateau, Garfield County, Utah, *L. F. Ward 541* (GH)!

Distribution: Dry rocky crests above timberline, gravelly places in open pine-forest, barren knolls in sagebrush valleys, more rarely in mountain parks or on stony lake shores, between 5600 and 11,500 ft. altitude, from the plateau region of south-central Utah to the Kaibab, Arizona, and across central and southern Nevada to the San Bernardino Mountains, California. Map 4.

Representative collections: California. Mt. San Gorgonio, San Bernardino County, *Abrams & McGregor 754* (GH, NY). Nevada. Charleston Peak, Clark County, *Clokey 5517* (CAS, GH, NY, POM, RB, WTC). Monitor Valley near Lone Mt., *Ripley & Barneby 6214* (CAS, GH). Utah. Near Cedar City (labelled "s. Utah," but cf. Amer. Nat., 9: 203, 270, 1875, under *O. campestris* var.?), Iron County, *Parry 55* (GH, NY). Mt. Ellen, Henry Mts., Garfield County, *M. E. Jones 5674* (NY, POM, US). Arizona. V. T. Park, Kaibab Forest, Coconino County, *Goodman & Hitchcock 1626* (CAS, NY).

Oxytropis oreophila is a most instructive species, displaying a degree of variability and a sensitivity to environment unsurpassed by many a more widely ranging species so that it presents, in a relatively small and compact area, most of the problems encountered in the genus at large. The principal modes of variation can be described as xerophytic and mesophytic. In the first there is a tendency toward reduction in length of peduncle, in amplitude of foliage, and in number of flowers to the raceme, while the bracts become short and narrow, and the caudex stout, intricately branched and clothed in a thatch of marcescent leaf-bases. The extreme in this direction is a pulvinate cushion with flowers and pods, two or three to a stem, resting at the level of the leaves or embedded in them, and it occurs not only above the limit of trees, as on the summits of the San Bernardino Mts., but also between six and seven thousand feet in the pseudo-alpine environment of barren knolls in the valleys of central Nevada and southern Utah. The relatively mesophytic opposite, especially well developed in the parks of the Kaibab Plateau, and on lake shores in the mountains of Utah, is a more slender plant composed of a few crowns almost naked of marcescent petioles, with elongate, erect scapes bearing several-flowered racemes lifted well above the leaves, while the bracts become larger or even foliaceous, and the vesture of the stipules and of the more ample leaflets is thinner and less silvery. At intermediate levels, as the plants descend from the summit screes into richer soils and more protected sites in the timber belt, the distinctive aspect of the alpine state is diminished, each character varying independently of others into the opposite condition. Large collections from any one station show something of the same variation. Thus Mr. Howell's fine series from Mt. San Gorgonio (*J. T. Howell 23668*, CAS, RB) includes densely pulvinate mats as well as looser individuals with exserted peduncles. In the region of Bryce Canyon, Utah (Red Canyon, *Ripley & Barneby 8546)*, gnarled, woody-caudexed cushions were found on open gravel ridges which, seeding down into a wash among the yellow pines, gave rise to lax and slender tufts with obscurely developed caudex, longer and more ample leaves and larger flowers. The Charleston Mt. material, from "broken rock just below timberline," combines the condensed foliage and few-flowered raceme of the alpine state with scapes as long, though prostrate, as found in the mesophytic extreme. Conversely diminutive plants from Hatch, Utah (*Pierson 12606*, RB), are long-bracted and many-flowered. Since like diversity, little or not at all correlated with habitat or distribution, exists in length of calyx-teeth, length and width of petal, in outline of pod, and in other characters, it seems impossible to recognize in *O. oreophila* more than a single plastic species.

Oxytropis oreophila was described from Ward's Utah material and from two collections (*W. G. Wright in 1879*, GH; *Lemmon 1470*, GH) from the San Bernardino Mts., California. Wheeler (l. c., sub *Astragalo Munzii)* has designated *Ward 541* as lectotype, a choice that is readily accepted. Apart from a mistaken record from Idaho (Rydb., Fl. Rocky Mts., 520, 1917) there has been no confusion as to the range or identity of *O. oreophila*. Gray's "possible variety . . . or related species, with flowers immersed in the tufts of foliage" (Proc. Amer. Acad., 20: l.c.) alludes to *Ward 574* (GH, US), from Rabbit Valley, Utah, which represents the condensed form of low altitude (in this case about 6800 ft.) mentioned above. The specimens, to which Gray gave an unpublished varietal name with the pencilled query, "an *oreophila* pedunculis brevissimis?" have unusually small flowers and short calyx-teeth. Except for these characters, quite variable in the species, the material well matches *Ripley & Barneby 4753* from 6700 ft. in eastern Sevier County, Utah, about twenty miles north of Rabbit Valley.

The species closely resembles *O. Parryi*, which varies in parallel, though less extreme, fashion. The latter is distinguished by the narrow, coriaceous pod and constantly few-flowered raceme. A form of *O. Lagopus* var. *atropurpurea* with uncommonly short, subglobose and inflated pod bears a strong resemblance to some states of *O. oreophila*, but differs in the much larger corolla with dilated wing-petals.

8. **Oxytropis Jonesii** Barneby, new species

Oxytropis Jonesii, sp. nov. ex affinitate *O. oreophilae* Gray, cujus a formis et maxime congestis et paucifloris corolla legumine necnon seminibus majoribus, foliolis paucis tantum 1–3-jugis, aliisque notulis diversa. — ? *O. multiceps* var. *minor* sensu Graham, Ann. Carn. Mus. 26: 256. 1937; non Gray.

Herba acaulescens densissime pulvinata, caudicis multicipitis lignei ramulis crassis 1–5 cm. longis stipulis marcidis arcte indutis columnaribus; foliis rosulatis 0.7–2 cm. longis suberectis, pilis argenteis patulis vel adscendentibus ubique sericeis; stipulis ad 6 mm. usque longis, petiolo brevissimo alte adnatis, extus pilosis vel laminis liberis deltoideis 1–1.5 mm. longis piloso-ciliatis dorso nonnumquam glabratis; foliolis 1–7 ellipticis obtusiusculis 2–5 (7) mm. longis, subpalmatim congestis vel rachi ad 6 mm. usque longo producto pinnatis; pedunculis piloso-hirsutis 0.3–1 (2.5) cm. longis folia rarissime superantibus; racemo 1–3 (5) -floro, subcapitato, fructifero haud elongato, floribus patulis; bracteis lineari-oblanceolatis 2–5 mm. longis, extus pilosis; pedicellis 0.5–2 mm. longis; calycis profunde campanulati pilis brevibus fuscis longisque argenteis commixtis dense piloso-hirsuti tubo (4.5) 5–7 mm. longo demum rupto, dentibus deltoideis vel ovato-subulatis 1.5–2.5 mm. longis; corolla violaceo-purpurea; vexillo late oblanceolato vel obovato 14.5–16 mm. longo, 6–9 mm. lato, emarginato; alarum 14–16 mm. longarum limbo oblique dilatato truncato vel leviter retuso 3.5–5 (6) mm. lato, auriculo (2 mm.) incluso 8–9 mm. longo; carinae 11–12.5 mm. longae laminis (appendiculo subulato subrecto circa 1 mm. long incluso) 6–7 mm. longis; legumine sessili vel subsessili (stipes saepissime obsoleta raro 0.6 mm. usque longa producitur) ovoideo vesicario-inflato, paullo obcompresso, 1.5–2.5 cm. longo, in rostrum conico-deltoideum compressum 2–4 mm. longum leviter declinatum abruptiuscule angustato, ventraliter sulcato, valvulis chartaceis, villis patulis pallidis (saepissime brevioribus pullis adspersis) hirsutulis, secus suturam ventralem anguste inflexis ut alam intus productam 1.2–2 mm. latam efforment; ovulis numerosis; seminibus fusco-castaneis 2.8–3 mm. longis. *Type:* pink calcareous gravel benches, Red Canyon, Garfield County, Utah, alt. 7150 ft., 7 June 1947, fl. & fr., *Ripley & Barneby 8550,* in Herb. Calif. Acad. Sci. *No. 337311;* isotypes GH, NY, WYO.

Distribution: Bare gravelly knolls and ridges, on shale or limestone, alt. 6300–7750 ft., Paunsagunt and East Tavaputs plateaux, Utah, Map 4.

Specimens examined: UTAH. Red Canyon, 10 mi. w. of entrance to Bryce Canyon, *C. L. Hitchcock 2964* (WTU). 2 mi. w. of Bryce Canyon, *Degener 16442* (NY). Bryce Canyon, *M. E. Jones in 1919* (POM), *Eastwood & Howell 728* (CAS). Widtsoe, foothills of Escalante Range, *Ripley & Barneby 8572* (CAS). Watson-Ouray road, 5 mi. w. of Bitter Creek, Uintah County, *E. H. Graham 8989* (GH, US).

Oxytropis Jonesii is clearly related to, and perhaps derived from *O. oreophila,* the most dwarf and pulvinate, few-flowered states of which are similar in appearance. The greater size of the flowers and fruits, combined with leaves reduced both in amplitude and in number of leaflets, distinguish it immediately. It was at first suspected that the early collections represented no more than a modification of the plastic *O. oreophila* to the peculiar environment of naked limestone benches on the Paunsagunt Plateau; but in Red Canyon a colony of typical *O. oreophila,* with well-furnished racemes of small flowers, developed peduncles and elongate 9–11-foliolate leaves, was found growing under apparently identical conditions a few paces from the group of plants from which the type of *O. Jonesii* was taken. In Garfield County, where *O. Jonesii* has been met with in half a dozen stations, the species is abruptly confined to ridges of the pink Wasatch limestone where it forms densely packed cushions of silvery foliage 1–3 dm. in diameter, liberally decorated with almost stemless violet flowers or the dusky bladders of the fruit. It is associated with several narrow regional endemics of other genera, such as *Lomatium minimum, Townsendia minima, Silene Petersonii* var. *minor, Eriogonum aretioides,* and *Draba subalpina,* and a distribution similar to theirs might be expected. It may be that the *Oxytropis* from the Green River shale in southern Uintah County belongs to a distinct race or species. The material is young and does resemble *O. multiceps* var. *minor* to which Graham referred it, but the broad floral bracts characteristic of *O. multiceps* are lacking. Apart from slightly more numerous (2–5) flowers to the raceme, the plants from this outlying station seem an excellent match for those to the west. Certain identification must await discovery of the fruit.

Oxytropis Jonesii is dedicated to the memory of Marcus Eugene Jones, pioneer botanist in the Great Basin and monographer of American *Astragalus,* who discovered the species in 1919.

9. **Oxytropis Parryi** Gray

Oxytropis Parryi Gray, Proc. Amer. Acad., 20:4. 1884. *Spiesia Parryi* (Gray) O. Kze., Rev. Gen., 206. 1891. *Aragallus Parryi* (Gray) Greene, Pittonia, 3:211. 1897. *Astragalus Parryanus* Tidestr., Proc. Biol. Soc. Wash., 50:19. 1941 (as *"parryanus")*; non *A. Parryi* Gray.

Low and densely cespitose, the several crowns clustered on a taproot, the branches of the caudex densely clothed with a thatch of persistent petioles and leaf-bases; herbage densely silky-pilose throughout, canescent or tawny in age, the hairs loosely to strictly appressed; stipules membranous becoming chartaceous, at first connate opposite the petiole but early ruptured, pilose dorsally, or the triangular to shortly acuminate ciliate free blades (2–4 mm. long), especially of those subtending secondary leaves, at length glabrate; leaves (1.5) 2.5–7 cm. long, somewhat dimorphic, erect or spreading, the petioles 0.5–2.5 (3) cm. long; leaflets 9–15 (17), narrowly oblong, elliptic or ovate, acutish or obtuse, 2.5–12 mm. long, flat or involute-conduplicate, commonly crowded and subcontiguous; scapes either strict, sigmoid-arcuate, ascending or prostrate, 2.5–7.5 (10) cm. long, equalling or surpassing the leaves, appressed-pilose but often bearing a few loosely ascending hairs, especially below the inflorescence; racemes subcapitately 1–3, usually 2-flowered, the flowers nearly erect; bracts lanceolate, acutish or obtuse, 3–7 mm. long, pilose dorsally; calyx deeply campanulate, 5–8 mm. long, densely hirsute with mixed short dark and longer pale hairs, the early ruptured tube 3–5.5 mm., the teeth 1.5–2.5 mm. long; corolla dull purplish; banner obovate, 7.5–10.5 mm. long, 3–5 mm. broad near the emarginate apex; wings 8–9 mm. long, the blades oblong or obliquely elliptic, about 5.5 mm. long, 2–2.5 mm. broad near the truncate or obtuse apex; keel 8–9 mm. long, the blades 4.5–5 mm. long including the small conic or subulate appendage; pod erect, sessile, lance-ovoid or narrowly oblong-acuminate in outline, 13–22 mm. long, 4–6 (8) mm. in diameter, the body passing upward into a short, slightly divaricate or straight beak, a trifle obcompressed, deeply sulcate ventrally, the valves chartaceous and stiff at maturity, shortly and densely pilosulous and strigose with mixed pale and dark hairs, the ventral suture produced inward as a false septum 1–2 mm. wide, almost or quite traversing the chamber; seeds dark-brown, 1.8–2 mm. in diameter. *Type* collected by C. C. Parry, in 1867, in the "Rocky Mountains of northern New Mexico and Colorado, near the limit of trees," more precisely at Sangre de Cristo Pass, Taos County, New Mexico; *Parry 41* (GH)!

Distribution: Stony ridges and screes, above or rarely below timberline, altitude 8900–12,000 ft., in the mountains surrounding and within the Great Basin, from northwestern Wyoming and central Idaho to transmontane middle California and northern New Mexico. Map 4.

Representative collections: IDAHO. E. of Castle Peak, Custer County, *Hitchcock & Martin 10880* (CAS, NY, WTC, WTU). WYOMING. Piney Mt., Sublette County, *E. & L. Payson 2706* (GH, NY, POM). CALIFORNIA. Inconsolable Range above Thunder and Lightning Lake, Inyo County, *J. T. Howell 24115* (CAS, RB). Mt. Patterson, Sweetwater Mts., Mono County, *Alexander & Kellogg 4545* (UC). NEVADA. Toiyabe Dome, Nye County, *Maguire & Holmgren 25995* (NY, RB, WTC). Wheeler Peak, White Pine County, *McVaugh 6028* (UC). UTAH. Scofield, Carbon County, *M. E. Jones in 1904* (CAS, NY). La Sal Mts., *E. & L. Payson 2706* (GH, NY). COLORADO. Little Veta Mt., Huerfano County, *Rydberg & Vreeland 5998* (ND, NY). Fairplay, Park County, *Ripley & Barneby 10375* (CAS). NEW MEXICO. Pecos Baldy, Mora County, *V. Bailey 616* (US).

With its oblong, erect legume and subcapitate raceme of one to three tiny purplish flowers, *O. Parryi* is distinct and almost unmistakable. In general facies it most closely resembles *O. oreophila,* varying like that species in the orientation of the scapes, in the amplitude of the leaflets, and to some degree in the size of the calyx and corolla; but the pod is much narrower, bilocular or nearly so, and of a thicker and tougher texture. In the high Rocky Mountains the ranges of *O. Parryi* and the Arctic-Alpine *O. podocarpa* overlap. Although the raceme of *O. podocarpa* is also reduced to about two flowers, the corolla is much larger than that of *O. Parryi* (the banner about 15 mm. long), the vesture is different, and the pod is stipitate and bladdery-inflated.

The species was first collected, in fruit, by Hall and Harbour in 1862, and distributed with flowering material of *O. podocarpa* under the same *No. 143* (GH, NY). Gray at first referred it (Proc. Philad. Acad., 1863, p. 61) to *O. arctica,* at that time unknown to him, and subsequently (Proc. Amer. Acad., 6: 235, 1864) to *O. uralensis* var. *pumila,* a name used to cover a miscellany of dwarf and imperfectly understood species. Finally *O. Parryi* came to be based on specimens collected by "Parry, Hall, & Harbour, Greene"; of them the first cited, *Parry 41* in the Gray Herbarium, is the obvious lectotype.

Like some other members of the genus, notably *O. viscida, O. Parryi* is characteristically a plant of great altitudes, where it occurs in open stony ground near timberline; but it is also found much lower, well down in the Arid Transition zone. During an ascent of Ward Mountain in eastern Nevada, *O. Parryi* was encountered in some abundance on broken limestone outcrops two or three hundred feet below the main forest belt *(Ripley & Barneby 4014,* CAS). Such small denuded areas surrounded by sagebrush and exposed to high winds and extreme drought are probably similar microclimatically to the subalpine screes generally preferred by the species.

10. **Oxytropis multiceps** T. & G.

Oxytropis multiceps T. & G., Fl. N. Amer., 1:341. 1838. *Physocalyx multiceps* Nutt. ex Gray, Proc. Amer. Acad., 6:234. 1864, in syn. *Spiesia multiceps* (T. & G.) O. Kze., Rev. Gen., 206. 1891. *Aragallus multiceps* (T. & G.) A. Hell., Cat. N. Amer. Pl., 4. 1898. *Astragalus bisontum* Tidestr., Proc. Biol. Soc. Wash., 50:18. 1937 (as "*Bisontum*").

Oxytropis multiceps var. *minor* Gray, Proc. Amer. Acad., 20:2. 1884. *Aragallus multiceps* var. *minor* (Gray) A. Nels., Erythea, 7:57. 1899. *Aragallus minor* (Gray) Ckll. ex Daniels, Univ. Mo. Sci. Stud. II, 2:158. 1911. *Oxytropis minor* (Gray) Ckll., Torreya, 18:180. 1918, nomen (without citation). *Astragalus bisontum* var. *minor* (Gray) Tidestr., Proc. Biol. Soc. Wash., 50:18. 1937.

Dwarf and cespitose, the pluricipital caudex more or less invested with marcescent stipules and petioles; herbage silky-pilose, silvery or sometimes greenish, the petioles scapes and stipules variably ascending-pilose; stipules membranous, pale, amplexicaul but never connate, lanceolate or ovate-lanceolate, 4–14 mm. long, the deltoid to lanceolate free blades (2) 3–6 mm. long, the whole hirsute or silky-pilose dorsally, rarely becoming glabrate, at length chartaceous-persistent; leaves 1–5 cm. long, the slender petioles 0.5–2.5 cm. long; leaflets 5–9, lanceolate, oblanceolate, elliptic, or ovoid-oblong, acute or rarely obtuse, (3) 5–13 mm. long, disposed on a rachis scarcely longer than the lowest pair; scapes spreading and at length prostrate, 1.5–3 cm. long, equalling or commonly surpassed by the leaves;

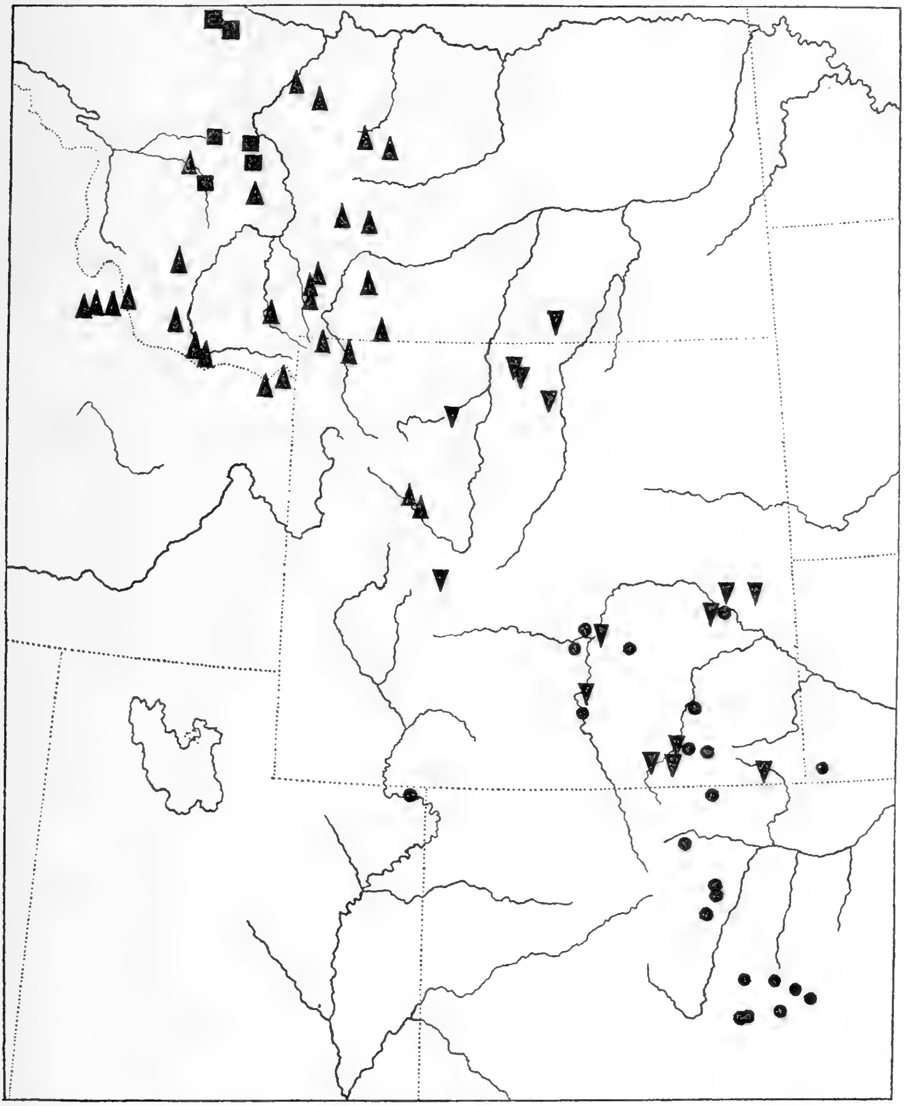
racemes subcapitately (1) 2–4-flowered, the axis not exceeding 5 mm. in length; bracts herbaceous, ovate or broadly lanceolate, obtuse to shortly acuminate, (3) 5–7 mm. long, thinly pilose or rarely glabrescent dorsally; pedicels slender, 1–1.5 mm. long, articulate at base and deciduous with the calyx; calyx strongly turgid at anthesis, somewhat attenuate at base, membranous, reddish and densely villous-hirsute with white hairs, the tube 5.5–10 mm., the unequal teeth 2–3 mm. long, in fruit becoming bladdery-inflated, 8–18 mm. long, 5–9 mm. in diameter, constricted at the mouth, the teeth erect or connivent; corolla bright pink-purple with a striate diamond in the banner, drying bluish; banner 17–24 mm. long, the broadly oblong-obovate emarginate blade about 9 mm. broad; wings dilated upward and 4.5–5.5 mm. wide near the emarginate apex; keel 13–18.5 mm. long, the blades, including the straight or recurved appendage (0.5–1.2 mm.) obliquely elliptic, 6–7 mm. long; pod included in the calyx and falling with it, stipitate, the stipe 0.5–1.5 mm. long, the ovoid-ellipsoid body 6–10 mm. long, contracted into a straight subulate beak up to half as long, somewhat dorsoventrally compressed and sulcate ventrally, 3–5 mm. in diameter, the valves thinly chartaceous, short-villous, the ventral suture produced inward as a flange 0.5–1 mm. wide, forming a partial false partition; seeds dull, orange- or pinkish-brown, sometimes purple-speckled, 1.5–2.1 mm. in diameter. *Type* collected by Thomas Nuttall, in 1834, on the "summit of lofty hills in the Rocky Mountain range, towards Lewis's River," i. e. southern Wyoming; "Rocky Mts," *Nuttall* (PH, GH, NY)!

Distribution: Gravelly summits and bare ridges between 6,000 and 10,200 ft. altitude, commonly on decomposed granite but also in detrital clays and sand, from southeastern Wyoming and adjacent Nebraska southward on the Atlantic slope to the Arkansas-South Platte divide in central Colorado, and westward to the Green River and the north slope of the Uinta Range in Utah. Map 5.

Representative collections: WYOMING. Crow Creek, Albany County, *A. Nelson 8969* (CAS, GH, NY). Fort Steele, Carbon County, *Tweedy 4199* (NY, US). NEBRASKA. Upper Lawrence Fork, Kimball County, *Rydberg 52* (NY, US). UTAH. Mann's Ranch near Flaming Gorge, Daggett County, *L. O. Williams 536* (NY). COLORADO. Without locality, *Hall & Harbour 144* (GH, NY, US). Headwaters of Clear Creek, Clear Creek County, *Parry 991* (GH, type of *O. multiceps* var. *minor*, NY). Caribou Mine, Boulder County, *Clokey 3279* (CAS, NY, POM, US, WTC). E. of Calhan, El Paso County, *Ripley & Barneby 7727* (CAS).

With its inflated calyx, broad bracts, loosely few-flowered raceme and few leaflets, *O. multiceps* is among the most distinctive species of the genus, yet it exhibits to some extent the variability characteristic of its kind. Here again are pygmy and giant phases, differing in size of calyx, petals, stipules, and leaflets. When Gray described the var. *minor*, he possessed only the

Nuttall type (with fruiting calyx 12 mm. and leaflets 6–10 mm. long) and a few examples of the dwarf extreme from the mountains (at about 10,000 ft.) of Colorado, these having the calyx 8–10 mm. and leaflets 3–7 mm. long. Subsequent collections have shown that these are no more than steps in an uninterrupted sequence, in which Nuttall's plant holds a central and representative position. If var. *minor* is maintained, logic demands a "var.



Map 5. Ranges of *Oxytropis multiceps* ●; and *O. Lagopus:* var. *Lagopus* ▲; var. *conjugans* ■; var. *atropurpurea* ▼.

major" for the opposite extreme, which differs from the type to the same degree. Lines of demarcation would be entirely arbitrary, and it seems best to accept all our material as belonging to a single variable entity. Some inconstancy in vesture may be noted also. On the desert plateaux of Wyoming, the stipules, petioles, and scapes are inclined to be more loosely and copiously hirsute than elsewhere in the range of the species. But complete intergradation into a sparser and more nearly appressed pubescence is apparent.

Oxytropis multiceps has been well understood from early days. Watson's report of it from Montana (Bot. King, Append., 446, 1871) was based on specimens of *O. Lagopus,* similar in the inflated and deciduous calyx. A record of var. *minor* from the Navajo Basin in Utah is discussed under the heading of *O. Jonesii,* above. The plants from the Flaming Gorge in northeastern Utah, already cited, were distributed by Williams under an unpublished binomial; except for the large calyx, sometimes exceeded at the other end of the species-area in Colorado, they are characteristic *O. multiceps.*

The binomial *O. multiceps* has been attributed from the first to Nuttall. It is true that the original description was taken from Nuttall's notes, but all parts of the type collection are labelled *Physocalyx multiceps* in the collector's hand, a genus which was never published. It seems probable that the species was referred to *Oxytropis* by the authors of the Flora of North America, rather than by Nuttall himself, and should be so cited.

11. **Oxytropis Lagopus** Nutt.

Low and densely cespitose, the several crowns clustered on the summit of a simple or forking taproot, the herbage everywhere silky-pilose with long silvery ascending or somewhat spreading hairs; stipules membranous and pale, at first connate opposite the petiole, but early ruptured, 7–17 mm. long, densely silky-pilose dorsally, or the deltoid to broadly lanceolate, ciliate blades (2–7 mm. long) sometimes glabrate in age, the whole at length chartaceous-persistent; leaves commonly dimorphic, (0.7) 1.5–11 cm. long, the more or less hirsute or villous petioles (0.3) 1–5 cm. long; leaflets 5–17, fewer and broader on the primary than on the secondary leaves, ovate-oblong to narrowly elliptic, acute or obtuse, involute or flat with elevated margins, 3–15 mm. long; peduncles erect, arcuate-ascending or subprostrate, 1–13 cm. long, closely appressed-pilose to copiously and finely villous-hirsute with horizontal hairs; racemes (3) 5–18-flowered, subcapitate to oblong at full anthesis, little elongating in fruit, the axis at maturity 0.5–3 (4) cm. long; bracts ovate-acuminate or lanceolate, 3–15 mm. long, somewhat involute and boat-shaped, densely shaggy-pilose dorsally, often with some dark hairs; pedicels slender, 1 mm. long or less, in fruit either firmly attached to the axis or articulate and readily deciduous; calyx at anthesis 8–11 mm. long, the deeply campanulate tube 5.5–7 mm., the linear-subulate teeth

2–4.5 mm. long, heavily silky-hirsute with all white, mixed, or largely dark shining villi which conceal the surface of the tube, in fruit becoming slightly turgid to strongly inflated and thus variably accrescent, either ruptured by the growing fruit or not; petals brilliant pink-purple or bluish-purple; banner 14–19 mm. long, the broadly ovate to ovate-oblong, deeply emarginate blade 7–10 mm. wide; wings 13–16 mm. long, variably dilated upward and 2–6 mm. wide near apex; keel 11–14 mm. long, the blades, including the subulate appendage, 6–7 mm. long; pod erect, either wholly enclosed in or far exserted from the calyx, shortly stipitate or sessile, ovoid to narrowly oblong, turgid to much inflated, ventrally sulcate and somewhat obcompressed, the body 6–15 mm. long, 4–6.5 mm. in diameter, passing abruptly or gradually into a straight or strongly divaricate beak 3–5 mm. long, the valves chartaceous to submembranous, the ventral suture produced inward as a narrow or rudimentary false septum 0.5–1 (1.5) mm. wide; seeds drab-, chestnut- or olive-brown, dull, 1.6–2 mm. in diameter.

In Montana and Wyoming, extending at middle altitudes from the upper Missouri about Great Falls and Helena south to Cheyenne and the Laramie plains, there are three similar and evidently related dwarf species of *Oxytropis* passing under the names *O. Lagopus, O. Blankinshipii,* and *O. atropurpurea.* In the *Flora of the Rocky Mountains,* Rydberg (sub *Aragallo)* placed *O. atropurpurea* in section *Campestres,* characterized by a pod at length exserted from a ruptured calyx, and the other two in section *Nani,* distinguished by inflated calyx and included pod; although *O. Lagopus,* on account of its "somewhat exserted" legume was keyed in both sections. From these keys it appears that *O. lagopus* should differ essentially from *O. atropurpurea* in the darker color of the petals and calyx-hairs, and from *O. Blankinshipii* in the longer pod and spreading-villous scape. Strict application of these criteria results in an artificial arrangement. It is possible to sort the material into three distinct groups, but these cut right across the lines laid down by Rydberg. The most distinctive entity, to which belong the type of *O. Blankinshipii* and, almost beyond a doubt, the original *O. Lagopus* of Nuttall, is the prevailing member of the alliance along the forks of the Missouri in southwestern Montana and the Yellowstone region. Here the pod is not only included in an inflated calyx but is early deciduous with it, the pedicels being jointed to the axis and deciduous before dehiscence of the fruit. Individual plants with this type of fructification, and surely conspecific, may have scapes appressed-pilose, sparsely hirsute with ascending hairs, or copiously villous, the villous state being a mark of *O. Lagopus* in Rydberg's sense. To the south, almost entirely within Wyoming, the true *O. Lagopus* is replaced by a plant, altogether similar in facies, herbage, and flower, but with pod well exserted, rupturing the feebly distended calyx and persistent at least until dehiscence. Here the scapes are commonly long-villous but may be appressed-pilose, and the calyx is often, though by no means always, pubescent with dark hairs. The nigrescent phase corresponds with Rydberg's *O. atropurpurea,* the rest with his *O. Lagopus.*

It should be emphasized that these two races, variable as they are in parallel directions, are indistinguishable in early anthesis. In each, the secondary leaves are lanceolate in outline, and the leaflets number between nine and seventeen (rarely seven in the primaries), and are well distributed along the rachis. But the fruit is in each case characteristic, and they might almost be maintained in the rank of species, were it not for the occurrence toward the northern limit of true *O. Lagopus,* within the range, in fact, of that species, but disjunct from that of *O. atropurpurea,* of a troublesome intermediate form. This, described below as var. *conjugans,* has exactly the corolla and young calyx of the two preceding, but the leaflets are fewer, commonly large and more congested on the rachis, resulting in a leaf of broadly oblong outline, and the entire plant is yet more copiously villous with exceptionally long, almost arachnoid hairs. In plants of this type, known only from a restricted area in western Montana, the calyx may either become strongly inflated and enclose the pod, or only a little turgid and at length ruptured by the exserted pod. The whole fruit is persistent at least until dehiscence, as in *O. atropurpurea,* but in form breaks down the last distinctions between that species and typical *O. Lagopus.* Since the corolla, young calyx, and (in all but length and degree of inflation) the pod of these three races are identical, it seems best to unite them as varieties under a common specific name.

KEY TO THE VARIETIES OF O. LAGOPUS

1. Mature secondary leaves lanceolate in outline, with 9–17 leaflets well-distributed along a rachis several times longer than the longest leaflet................ 2

— Mature secondary leaves broadly oblong in outline, not much longer than broad, with 5–9 leaflets congested on a rachis 5–13 mm. long, about equalling the longest leaflet. Pod variable in length, either included in or exserted from the moderately inflated calyx which, ruptured or not, loosely invests and persists with the legume until dehiscence.. b. var. *conjugans*

2 Calyx early becoming inflated, somewhat accrescent, enclosing the short pod and deciduous with it before dehiscence.. a. var. *Lagopus*

— Calyx little or not at all inflated, ruptured by the exserted pod and persistent with it until dehiscence or after.. c. var. *atropurpurea*

11a. **Oxytropis Lagopus** Nutt. var. **Lagopus**

Oxytropis Lagopus Nutt., Jour. Acad. Philad., 7:17. 1834 (as "*lagopus*"). *Spiesia Lagopus* (Nutt.) O. Kze., Rev. Gen., 206. 1891. *Aragallus Lagopus* (Nutt.) Greene, Pittonia, 3:212. 1897. *Astragalus Lagopus* (Nutt.) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937.

Aragallus Blankinshipii A. Nels., Erythea, 7:58. 1899, pro parte, emend. Rydb., Bull. Torr. Club, 34:422. 1907. *Oxytropis Blankinshipii* (A. Nels.) K. Schum., Just's Jahresb., 27^1:496. 1901. *Astragalus Blankinshipii* (A. Nels.) Tidestr., Proc. Biol. Soc. Wash., 50:18. 1937.

Habit of the species; scapes erect, arcuate-ascending or procumbent, 3–13 cm. long, either appressed-pilose, ascending-pilose, or villous-hirsute; racemes 6–18-flowered; calyx becoming turgid, in fruit accrescent, ovoid-urceolate and ventricose-inflated, 10–14 (18) mm. long, constricted at the mouth and enclosing the legume, not ruptured; pod commonly minutely stipitate, the ovoid body 6–10 mm. long, 4–5 mm. in diameter, passing into a short deltoid or lanceolate beak about equalling the connivent calyx-teeth; pedicels articulate with the axis in fruit, deciduous with the calyx and pod before dehiscence. *Type* collected by Nathaniel B. Wyeth, in 1833, about the sources of the Missouri; sources of the Missouri, *Wyeth* (PH, NY)!

Distribution: Sandy bluffs, grassy hillsides, and gravelly knolls, sometimes among sagebrush, altitude 4,200–7,000 ft., western Montana and east-central Idaho to Yellowstone Park and the upper Wind River, Wyoming. Map 5.

Representative collections: IDAHO. Henry Lake, Fremont County, *E. & L. Payson 2028* (CAS, GH, NY). MONTANA. Monida, Beaverhead County, *A. & E. Nelson 5421* (GH, ND, NY, POM, WTC). Middle Creek, 15 mi. sw. of Bozeman, Gallatin County, *J. W. Blankinship in 1898* (GH, NY, in part, isotypes of *Aragallus Blankinshipii).* N. of Big Timber, Sweet Grass County, *Ripley & Barneby 8069* (CAS, NY). WYOMING. N.-w. Wyoming (probably Yellowstone Park; cf. Jones, Rep. Reconn. NW. Wyo., 310, sub *O. Lambertii* var.), *Parry 91* (GH, NY). Dubois, Fremont County, *Ripley & Barneby 8913* (WYO).

The var. *Lagopus* is unmistakable in fruit, being the only species of its region, except for a rare form of var. *conjugans,* with inflated calyx. It is one of the earliest spring flowers, and by mid-June is commonly past anthesis, when the low silvery tufts, often surrounded by a ring of fallen calyces, become an inconspicuous feature of the hillside flora. Variation follows a pattern usual in the genus, dwarf and relatively giant phases being not uncommon. The scapes vary from erect to prostrate, and though most commonly appressed-pilose, they may on occasion be copiously hirsute or villous. The calyx-hairs vary greatly in color; the wing-petals may be either narrowly oblong or much dilated upward; and the pod and fruiting calyx fluctuate greatly in length and diameter. But these are trivial variations which occur independently of each other, and are without taxonomic significance.

The identity of the type of *O. Lagopus* cannot be made out beyond all chance of controversy from the immature and fragmentary type. Wyeth's plants are barely coming into flower, and the ultimate state of the calyx and pod can never be established. In the region traversed by Wyeth, "between the Falls of the Columbia and the first navigable waters of the

Missouri,"[4] two forms of *O. Lagopus* are now known, the rare var. *conjugans* and the much commoner phase which passes as *O. Blankinshipii,* the var. *Lagopus* of this paper. These differ at young anthesis principally in the number of leaflets. In the type, unfortunately, most of the leaves are incomplete, but one primary leaf (NY) has nine leaflets, as opposed to the usual five or seven in var. *conjugans.* Although the evidence is not conclusive, it seems most probable that Wyeth had the common var. *Lagopus.*

The application of the name *Lagopus* to a plant with exserted pod, current for many years, can be traced back to Gray's second revision of *Oxytropis* (1884). In his earlier study (1864) he had reduced *O. Lagopus* to a mixed and chimerical *O. uralensis* var. *pumila,* but the intervening decades had brought to light further material from Montana and Wyoming which enabled him to revive and redefine the species. Gray's *O. Lagopus* of 1884 was a mixture of the Montana plant with included pod *(Scribner 29a* from Bozeman, in flower only) i. e. var. *Lagopus,* and var. *atropurpurea (Parry 92; Greene* from Cheyenne) with exserted pod. He did possess fruiting material of var. *Lagopus* in the shape of *Parry 91* from Yellowstone, but this, probably because its scapes were, unlike the rest, appressed-pilose, he referred to *O. nana,* the pod of which was first, most erroneously, described from these specimens. Thus in 1884 Gray's *O. nana,* as to the fruit, was var. *Lagopus,* while his *O. Lagopus,* as to the fruit, was the Wyoming var. *atropurpurea.* These errors, natural at the time, still echo in the literature. Rydberg conceived *O. Lagopus* as having villous scapes and the pod somewhat exserted, thus including with most of var. *atropurpurea* (when lacking conspicuously black calyx) and the whole of var. *conjugans* a large element of var. *Lagopus* (when in flower). Simultaneously he was maintaining an *O. Blankinshipii,* supposedly with included pod and appressed-pilose scapes, and referring otherwise similar material with ascending scapes to *O. nana,* here following Gray's disposition of *Parry 91.* Aven Nelson, evidently baffled by the ambiguous treatments of *O. Lagopus* and *O. nana,* suggested (Univ. Wyo. Pub. Bot., 1: 118, 1926) that they were synonymous, as current concepts of them indeed were, in greater or less degree.

Oxytropis Blankinshipii has itself had a confused history. It was originally described by Nelson from fruit of *O. Lagopus* and flowers of *O. Besseyi,* as pointed out by Rydberg (1907, l. c.), who restricted the name to the fruiting element. On yet another mixture involving *O. Lagopus* Nelson founded his *Aragallus collinus,* the flowering (and as emended by Rydberg, typical) element being in this case a specimen of *O. nana.* The *Aragallus*

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[4] According to Blankinship (Mont. Agric. Sci. Stud., 1:6—1905), Wyeth entered Montana along Clark's Fork in April 1883, and after following this stream as far as Missoula, turned south up the Bitter Root, across into the Big Hole Basin, and thence over to the Salmon River in Idaho. It can be assumed, from their youthful condition, that the specimens of *O. Lagopus* were collected in early spring, certainly not later than May, and probably therefore in the Bitterroot or Big Hole valleys.

collinus of Rydberg's Flora of Montana corresponds however with the original fruiting character, and is thus pure var. *Lagopus.*

The specific epithet, both written and published by Nuttall as "*lagopus,*" was first capitalized by Torrey and Gray. The latter spelling seems more appropriate to a noun in apposition, and is probably best followed.

11b. **Oxytropis Lagopus** Nutt. var. **conjugans** Barneby, new variety

Oxytropis Lagopus Nutt. var. *conjugans*, var. nov., a prole typica necnon var. *atropurpurea* praesertim foliolis paucis secus rachin breviorem 3–13 mm. tantum longum confertis, ab eo etiam fructu diu persistenti absimilis. Legumen mediocre calyce adeo accrescenti nunc integro inclusum, nunc ventraliter fisso ad medium tantum usque suffultum.

Densely silky-lanuginous throughout, the scapes and petioles villous with fine horizontally patent hairs; leaves all short and congested on the crowns, broadly oblong, 0.7–4.5 cm. long, with 5–9 leaflets 5–13 mm. long crowded on a rachis about equalling the longest leaflet; racemes 5–9-flowered; scapes erect; calyx somewhat accrescent and inflated, either ruptured or not, entirely enclosing or but investing the lower half of the pod; body of the pod ovoid-oblong, 8–13 mm. long, about 5 mm. in diameter, passing upward into a short more or less divaricate beak; pedicels persistent with the calyx and fruit until dehiscence, not readily disarticulating. *Type:* Vicinity of Helena, Montana, June, 1921, *E. O. Wooton* in Herb. U. S. National Museum *No. 1086296;* isotype NY.

Distribution: Stony calcareous hilltops, at about 5,000 ft., in the valleys of the Missouri, Sun, and Teton rivers to the north and south of Helena, Montana, extending to the Pacific slope in the valleys of Clark's Fork and the Big Blackfoot River. Map 5.

Representative specimens: MONTANA. Helena, Lewis and Clark County, *Kelsey 229* (ND), *in 1886* (OB), *in 1888* (POM, UC, US). S.-e. of Helena, in Jefferson County, *Ripley & Barneby 8186*. Big Blackfoot River, *Pearsall 892* (NY). 15 mi. w. of Choteau, Teton County, *Hitchcock & Muhlick 18088* (RB).

The present variety resembles var. *atropurpurea* in the legume being persistent on the raceme until dehiscence. The calyx may be similar, little inflated and therefore ruptured, or at times strongly inflated and wholly enclosing the shorter pod, when the fruiting raceme resembles that of var. *Lagopus.* The broad short leaves with their few leaflets are distinctive. So far as known the scapes and petioles are always long-villous, and it is perhaps suggestive that the phase of var. *Lagopus* (with included and promptly deciduous pod) immediately contiguous in range shows an approach to this loose type of vesture. The var. *conjugans* seems neatly to fill the gap between var. *atropurpurea,* from which it is geographically disjunct, and var. *Lagopus* in whose range it seems to occupy a restricted island.

11c. **Oxytropis Lagopus** Nutt. var. **atropurpurea** (Rydb.) Barneby

Oxytropis Lagopus Nutt. var. *atropurpurea* (Rydb.), Barneby, Leafl. West. Bot., 5:111, 1951. *Aragallus atropurpureus* Rydb., Bull. Torr. Club, 34:424. 1907. *Oxytropis atropurpurea* (Rydb.) A. Nels., Univ. Wyo. Pub. Bot., 1:117. 1926.

Habit of var. *Lagopus,* but commonly more loosely pilose, the scapes and petioles as a rule copiously villous, sometimes thinly so or even appressed-pilose; calyx densely shaggy with light or dark hairs in varying proportions, little or not accrescent in fruit, ruptured by but closely investing the base of the exserted pod; body of the pod 8–15 mm. long, oblong or ovoid, turgid to decidedly inflated and 4.5–6.5 mm. in diameter, passing gradually or abruptly into a straight, divaricate, or even declined beak 4–5 mm. long; pedicels persistent at least until dehiscence. *Type* collected by Frank Tweedy, in 1898, on the headwaters of the Tongue River, Big Horn Mountains, Wyoming; *Tweedy 125, 126* (NY, cotypes)!

Distribution: Gravelly plains, knolls and open hillsides between 5,000 and 8,300 ft. altitude, nearly throughout Wyoming, from the Platte River drainage to the Big Horn Basin, adjacent southeastern Montana, and west to the head of the Green River. Map 5.

Representative specimens: MONTANA. Busby, Big Horn County, *Grinnell 45* (US). WYOMING. Sand Creek, Albany County, *A. Nelson 7039* (GH, NY, POM). Sour Dough Creek, Johnson County, *L. & R. Williams 3296* (GH, NY, WTC, WTU). N.-w. Wyoming, *Parry 92* (NY).

Like var. *Lagopus,* which it replaces at middle altitudes over most of Wyoming, var. *atropurpurea* varies considerably in stature, in the color of the calyx-hairs, in the orientation of the pubescence, and in the length and inflation of the pod. The cotypes of *A. atropurpureus* are especially robust and copiously villous, and the inflorescence is uncommonly dark, but we have approximate topotypes (Upper Tongue River, Sheridan County, *Ripley & Barneby 8021,* CAS, NY) in which the scapes may be sparingly villous, or with loose hairs almost lacking, and in which the proportion of dark hairs on bracts and calyces is quite variable. Some hairs of dark color are nearly always present, at least on the calyx-teeth, but they may be almost concealed by the longer pale villi which form the vesture characteristic of the species as a whole. The pod in the type emerges but little beyond the calyx-teeth, but it is found far exserted in otherwise similar plants. In one collection from South Pass, Fremont County, Wyoming *(Ripley & Barneby 7955,* CAS) the legume varies extraordinarily in outline, in some racemes being broadly and obliquely ovoid with sharply declined beak, in others oblong-ellipsoid and abruptly contracted into a nearly erect beak.

Material of var. *atropurpurea* has commonly been referred to *O. Lagopus* proper, and formed the basis of Gray's concept of the species, as also, in great part, that of Rydberg, Nelson, and others. In early years Nelson distributed several collections from near Laramie as *O. monticola,* but most subsequent ones were labelled *O. Lagopus. Aragallus atropurpureus,* at first reduced by Coulter and Nelson (New Man. 295, 1909) to *O. Lambertii,* was at length revived and transferred by Nelson to *Oxytropis.* No reason was then given for distinguishing it from *O. Lagopus* sensu Nelson, with which it is surely conspecific.

12. **Oxytropis Besseyi** (Rydb.) Blank.

Cespitose, with several to many crowns clustered on the summit of a pluricipital taproot, the short caudex-branches clothed with a thatch of persistent stipules and petioles; pubescence silky-pilose, loosely appressed except on the villous pod and the often spreading-hirsute calyx; stipules membranous, pale or sometimes herbaceous in youth, becoming chartaceous in age, 6–14 mm. long, more or less silky-pilose dorsally, the free blades narrowly to broadly deltoid, 1.5–5 mm. long, ciliate; leaves 1.5–12 cm. long, little dimorphic, the slender petioles 0.5–6 cm. long, appressed-pilose and often bearing some looser, ascending hairs; leaflets 5–21, approximate or discrete, narrowly elliptic, lanceolate or rarely lance-ovate, 4–21 mm. long, 1–4 mm. wide, flat or involute, equally pilose on both faces; scapes erect or ascending, rarely sigmoid-arcuate, 2–19 cm. long, often with a few ascending as well as appressed hairs; racemes 3–20-flowered, capitately subumbellate or loosely racemose at full anthesis, little or not at all elongating thereafter; bracts ovate-rhombic to lanceolate or lance-acuminate, 5–14 mm. long, 2–4.5 mm. broad near the base (where pallid, obscurely carinate and cucullate), flat and herbaceous above, silky-pilose dorsally and ciliate; calyx 9–13 mm. long, the cylindro-campanulate, membranous, purplish or ultimately stramineous tube 6–8 mm., the herbaceous, deltoid to lance-subulate teeth 3–6 mm. long; petals brilliant pink-purple, drying bluish, with a white, striate lozenge in the banner; banner 17.5–25 mm. long, expanded above the broad claw into an ovate-oblong or somewhat fiddle-shaped blade 6–8 mm. wide; wings 14.5–25 mm. long, the asymmetric blades 9–15 mm. long, obliquely dilated and 4.5–7 mm. wide near the emarginate apex; keel 12.5–18 mm. long, the blades 6–8.5 mm. long including the straight or arcuate appendage (0.3–2 mm.); pod splitting the calyx when fully formed but commonly invested by it, erect or spreading, shortly but manifestly stipitate, the stipe up to 1.2 mm. long and more less obliquely attached, the body 10–14 mm. long, variably inflated or turgid and 2.5–10 mm. in diameter, somewhat obcompressed and passing into a lanceolate more or less divaricate beak about 5 mm. long, the ripe valves chartaceous, scarcely rigid, villous with pale shining hairs 1.5–3 mm. long, the ventral suture produced inward as a flange 0.8–2 mm. wide, either traversing the chamber or, when the pod is much inflated, forming only a partial and incomplete septum; seeds brown, sometimes speckled with purple, 1.8–2.3 mm. in diameter.

Like most of our species, *O. Besseyi* displays extremes of nanism and gigantism. While the corolla, the proportions of the calyx and the vesture of the herbage remain constant within comprehensible limits, the plants show marked diversity in length of raceme, in number and size of leaflets, and in the incidence of long spreading hairs on the calyx. On the basis of these characters it is possible to make out five varieties, to some small extent intergradient, but with satisfactory individual areas of dispersal.

Key to the Varieties of O. Besseyi

1\. Calyx thinly hispid-hirsute, the hairs mostly widely spreading, about 2 mm. long 2

— Calyx appressed-silky, if with some loose hairs then these ascending at a narrow angle and shorter 4

2\. Racemes loose, 2–8 cm. long at full anthesis, on scapes 9–19 cm. long; leaflets 9–21, scattered on a rachis 2–9 cm. long. N.–e. Wyoming, in the drainage of Cheyenne and Powder rivers, n. to the Missouri in Montana, thence s.–w. to the Madison River and Yellowstone Park .... a. var. *Besseyi*

— Racemes dense, subcapitate, 0.5–2 cm. long at full anthesis, on scapes 2–9 (12) cm. long; leaflets 5–9 (11), crowded on a rachis 3–14 mm. long 3

3\. Leaflets of developed leaves 9–20 mm. long; Wyoming in the drainage of Green, Platte, and Wind rivers .... b. var. *ventosa*

— Leaflets of developed leaves 3–10 (13) mm. long; s.–w. and extreme w. Montana to adjacent Idaho .... c. var. *argophylla*

4\. Leaflets 5–9; racemes 7–10-flowered, subcapitate at anthesis, the axis becoming 1–2 (2.5) cm. long in fruit; Custer County, Idaho .... d. var *salmonensis*

— Leaflets 7–15; racemes 11–19-flowered, looser, the axis becoming 2.5–5.5 cm. long in fruit; Big Horn Basin, Wyoming .... e. var *fallax*

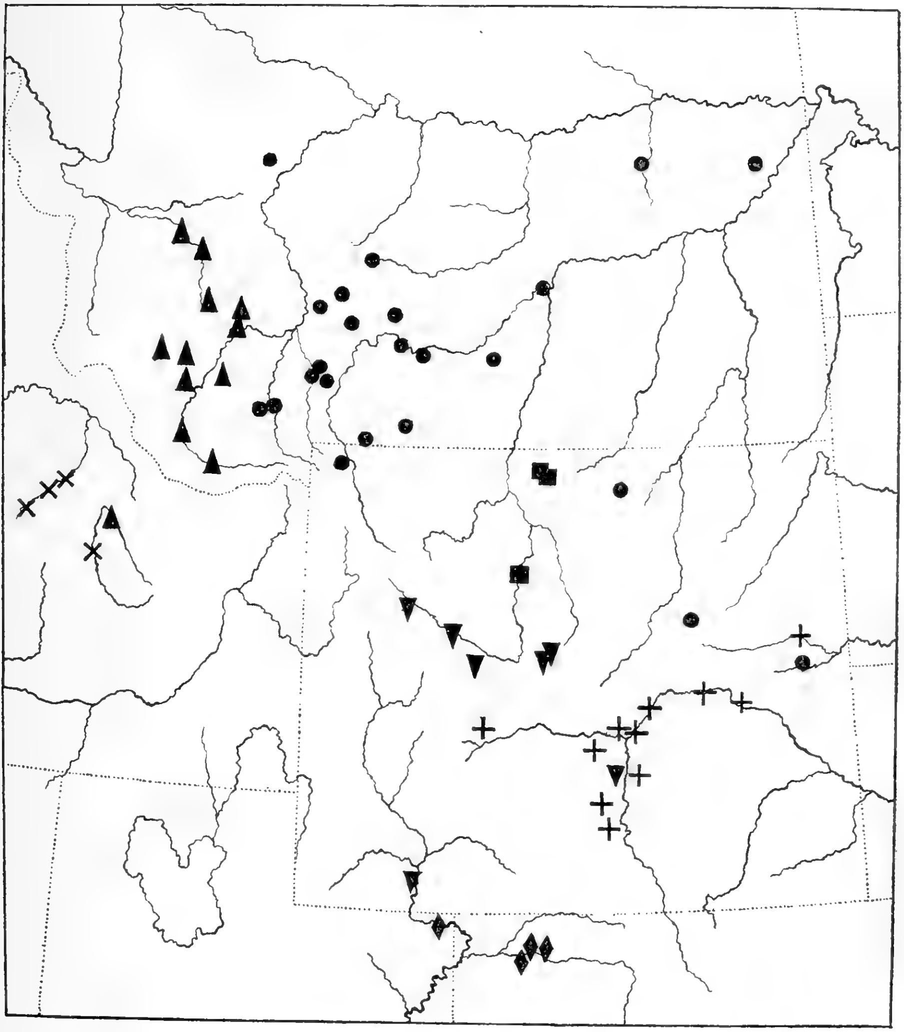
12a. **Oxytropis Besseyi** (Rydb.) Blank. var. **Besseyi**

Oxytropis Besseyi (Rydb.) Blank., Mont. Agric. Coll. Sci. Stud., Bot. 1:80. 1904; Dayton, Proc. Biol. Soc. Wash., 40:120. 1927 (as "comb. nov."). *Aragallus Besseyi* Rydb., Mem. N. Y. Bot. Gard., 1:250. 1900.

Commonly robust, the leaves 3–12 cm., the erect scapes 9–19 cm. long; leaflets (except in dwarfed or immature individuals) 9–19, scattered along a rachis much longer than the longest leaflet; racemes 7–20-flowered, oblong at anthesis, the axis 2–8 cm. long in fruit; calyx 9–13 mm. long, hispid-hirsute with long, shining hairs, the tube 6–7 mm., the teeth 3–6 mm. long; banner 18–25 mm. long; pod scarcely to considerably inflated, the body 8–14 mm. long, 2.5–5 mm. in diameter. *Type* collected by P. A. Rydberg and

Ernst A. Bessey, in 1897, at Spanish Basin, Madison County, Montana; *Rydberg & Bessey 4501* (NY, GH, ND, US)!

Distribution: Gravelly hilltops, river-bluffs, and sandy banks; widespread in Montana east of the Continental Divide, but especially abundant along the upper branches of the Missouri and Yellowstone rivers, to Yellowstone Park, and southward to the upper Powder and Cheyenne rivers in east-central Wyoming. Map 6.



Map 6. Ranges of *Oxytropis Besseyi:* var. *Besseyi* ●; var. *ventosa* ▼; var. *argophylla* ▲; var. *salmonensis* X; var. *fallax* ■; of *O. obnapiformis* ◆; and of *O. nana* +.

Representative specimens: MONTANA. "Banks of Clarck's River," *M. Lewis* (PH)[5]. Middle Creek, 15 mi. s.-w. of Bozeman, *Blankinship in 1898* (GH, NY, the collection from which the flower of *Aragallus Blankinshipii* was described; cf. infra). E. of Columbus, Stillwater County, *Ripley & Barneby 8056* (CAS, US). Custer, Yellowstone County, *Blankinship 152* (GH, NY, OB). WYOMING. Salt Creek Road, Natrona County, *Goodding 225* (GH, NY, POM). Yellowstone Park, *Rev. Chas Hall in 1888* (NY).

The typical variety of *O. Besseyi* is the handsome and robust Loco common on bluffs along the upper tributaries of the Missouri and the Yellowstone. It has been likened to *O. Lambertii,* with which it is occasionally associated, but the hispid-villous calyx, the thin-walled, villous pod, and the basifixed pubescence are distinctive. The calyx is apparently always broken eventually by the legume, but at maturity the pedicels are often insecurely attached to the axis of the raceme, so that calyx and pod tend to be deciduous together. But to the northeast, in somewhat more arid climate, plants occur in which the pod persists over winter on marcescent peduncles. The pod itself is variable in length, in degree of inflation, and in the width of the partition. When the partition is narrow and the valves strongly distended, the pod is almost wholly unilocular. At the other extreme a broad septum in a narrow pod produces a semibilocular or nearly bilocular condition. Intermediate states are found in otherwise like plants, and the depth of the partition has no taxonomic significance.

In western Montana var. *Besseyi* and *O. Lagopus* occur together, the former coming into flower in June when the other is already, at the same altitude, in advanced fruit. A mixture of the two collected by Blankinship near Bozeman became the basis of *Aragallus Blankinshipii* A. Nels. The diverse elements were early analyzed by Rydberg (Bull. Torr. Club, 34: 422, 1907) who, rejecting Blankinship's statement (Mont. Agric. Coll. Sci. Stud., Bot., 1: 80, 1904) that the mature plant with inflated calyx was infected by uredo, certainly untrue of the material seen by the writer, restricted the epithet *Blankinshipii* to the fruiting plant. It thus became a synonym of *O. Lagopus.*

According to Blankinship and Henshall, the species is known in Montana as "Red Loco" or "shoestrings."

12b. **Oxytropis Besseyi** (Rydb.) Blank. var. **ventosa** (Greene) Barneby

Oxytropis Besseyi (Rydb.) Blank. var. *ventosa,* Barneby, Leafl. West. Bot., 5:111. 1951. *Aragallus ventosus* Greene, Proc. Biol. Soc. Wash., 18:15. 1905.

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[5] This is the plant listed by Pursh, Fl. Amer. Sept. 473—1814, as *O. argentata* (not, however, of DC.), and according to Coues (Proc. Philad. Acad. 1898, p. 298—1899), who made a special study of Lewis and Clark's route, it must have been collected on July 1–2 in the Bitterroot valley at the mouth of its Lou-Lou branch, in the present Missoula County, Montana. This statement is difficult to reconcile with our knowledge of the range of *O. Besseyi* var. *Besseyi,* to which Lewis's plant unquestionably belongs. July, the month given also on the label, is late in the season for young flowering material of this species at an altitude not much exceeding 3,000 feet, and there may be some error in the original data.

Similar to var. *Besseyi,* but reduced; leaves 3–7 cm. long, with 5–7, rarely 9 flat leaflets (8) 10–21 mm. long, congested on a rachis 5–14 mm. long, usually shorter than the longest leaflet; racemes subcapitate at anthesis, remaining so in fruit, or the axis becoming up to 1.5 (2) cm. long; calyx 9–10.5 mm. long, the teeth 3–4 mm. long, the vesture as in var. *Besseyi;* banner 15–20 mm. long; mature pod not seen, but when young exactly as in var. *Besseyi. Type* collected by W. H. Forwood, in 1884, on dry ground in the valley of the North Fork of Wind River, Wyoming; *Forwood 65* (US, type, GH)!

Distribution: Arid stony hilltops, sandy banks, or cobblestone bluffs in the drainage of the Wind, Platte, and Green rivers of central and southern Wyoming. Map 6.

Representative specimens: WYOMING. Bird's Eye, Fremont County, *A. Nelson 9343* (GH, NY, POM, US, WTU). N.-w. Wyoming (i. e. Wind River, acc. Parry in Jones, Rep. Reconn. N.-W. Wyo., 310), *Parry 90* (GH), 29 mi. s. of Green River, *Ripley & Barneby 7896* (CAS).

The var. *ventosa,* maintained on slender characters, is obviously a minor entity, but it is readily recognizable and has a natural range to the southwest of its more robust counterpart, var. *Besseyi.* In stature it is intermediate between var. *Besseyi* and var. *argophylla,* in facies more like the latter, from which it is geographically disjunct.

The rather few known collections have been very differently disposed of in the past. Both the type and *Parry 90* were referred by Gray to his mixed "*O. nana.*" Nelson distributed several gatherings under an unpublished epithet "*coeruleus,*" but subsequently removed these (Univ. Wyo. Pub. Bot., 1: 113, 1926) to his "*O. sericea,*" a curious mixture of var. *ventosa* and *O. Lambertii* var. *Bigelovii* which has nothing whatever in common with the original *O. sericea* Nutt.

12c. **Oxytropis Besseyi** (Rydb.) Blank. var. **argophylla** (Rydb.) Barneby

Oxytropis Besseyi (Rydb.) Blank. var. *argophylla* Barneby, Leafl. West. Bot., 5:111. 1951 (Jan.); R. J. Davis, Madroño, 11:144. 1951 (Jul.). *Aragallus argophyllus* Rydb., Mem. N. Y. Bot. Gard., 1:255. 1900.

Dwarf and densely cespitose, the herbage silvery-white; leaves 1.5–4 cm. long, with 5–9, rarely 11, often involute leaflets 3–10 (13) mm. long, crowded on a rachis mostly shorter than the longest leaflet; scapes 2–7 (9) cm. long, erect, ascending or sigmoid-arcuate; racemes subcapitately 3–10-flowered, the axis 0.5–1.5 cm. long in fruit; calyx 9–10.5 mm. long, the teeth 3–4.5 mm. long, the vesture as in var. *Besseyi;* banner 17.5–21 mm. long; pod evidently inflated, 4–6 mm. in diameter. *Type* collected by J. G. Cooper, in 1860, on the "Little Blackfeet River, Montana"; *Cooper in 1860* (NY, type; GH, fragments)!

Distribution: Stony hilltops and river-bluffs, common about Butte, Montana, extending northwestward along Deer Lodge Valley and south into Beaverhead County and adjacent Idaho. Map 6.

Representative specimens: IDAHO. Head of Mahogany Creek, Lost River Mts., Custer County, *Hitchcock & Muhlick 11024* (CAS, NY, WTC, WTU). MONTANA. Armstead, Beaverhead County, *E. & L. Payson 1911* (CAS, GH, NY). Anaconda, Deer Lodge County, *Blankinship 769* (US). 7 mi. n. of Deer Lodge, Powell County, *Ripley & Barneby 8161* (CAS).

This dwarf *Oxytropis,* quite similar to var. *Besseyi* in flower and pod, but much diminished in stature, with few congested leaflets and capitate racemes, abruptly replaces the typical form of the species to the west of the Continental Divide. It is a minor but readily distinguished geographic entity.

The variety has often passed as *O. nana,* the early collections having been referred there in Gray's two revisions of the genus. These were in flower only and do superficially resemble the type of *O. nana,* but the calyx-teeth are longer, the vesture of the calyx is quite different, and the fruit is now known to be well exserted, at length becoming turgid and splitting the calyx.

12d. **Oxytropis Besseyi** (Rydb.) Blank. var. **salmonensis** Barneby

Oxytropis Besseyi (Rydb.) Blank. var. *salmonensis*, var. nov., foliolis paucis (5–9) adeo approximatis var. *argophyllae* atque var. *ventosae* (ut supra descriptis) habitu adspectuque similis, sed calyce subappresse sericeo nec pilis patulis hirsuto, et legumine maxime inflato subgloboso aberrans.

Similar to vars. b. and c., low and tufted; herbage appressed-silky throughout; leaves 4–8 cm. long; leaflets 5–9, rather crowded, 10–19 mm. long, the rachis 6–20 mm. long; scapes surpassing the leaves, racemes 7–10-flowered, subcapitate at early anthesis, the axis becoming 1–2 (2.5) cm. long in fruit; calyx silky with appressed and a few looser but closely ascending hairs, not spreading-hirsute, the tube 7–8 mm., the teeth about 3 mm. long; pod strongly inflated, the body subglobose. *Type:* Salmon River Canyon, 12 miles below Clayton, Custer County, Idaho, alt. 5,400 ft., 22 June 1947, *Ripley & Barneby 8829,* in Herb. Calif. Acad. Sci. *No. 338976;* isotypes NY, IDS.

Distribution: Friable clay declivities along the Salmon and Big Lost rivers in Custer County, Idaho. Map 6.

Specimens examined: IDAHO. Mackay, Custer County, *Nelson & Macbride 1567* (GH). Spar Canyon, 20 mi. e. of Clayton, *C. L. Hitchcock 15669* (RB). Below Clayton, *R. J. Davis 448* (IDS). 13 mi. sw. of Challis, *J. & C. Christ 17739* (RB).

The variety *salmonensis* is found in some quantity on soft, shaley clay banks of lateral canyons leading into the gorge of the Salmon River, where it is associated with *Thelypodium repandum* Roll. and *Astragalus amblytropis* Barneby, both close endemics recently described, and it seems to be a definite and isolated type, even though not distinguished from the rest of its species by very substantial characters. In habit it resembles var. *ventosa* and var. *argophylla,* the former especially in stature, but differs from both in the absence of long hirsute trichomes on the calyx, so characteristic of *O. Besseyi* as a whole (with the exception of var. *fallax* below), and in the strongly inflated legume. This inflation is so pronounced that Nelson identified his gathering from Mackay as *Aragallus inflatus (O. podocarpa),* a distantly related species known in the Rocky Mountains only from above timberline.

12e. **Oxytropis Besseyi** (Rydb.) Blank. var. **fallax** Barneby

Oxytropis Besseyi (Rydb.) Blank. var. *fallax,* var. nov., statura adspectuque var. *Besseyi* persimilis, et ab ea calycis subappresse sericei (nec pilis divaricatis hirsuti) dentibus paullo brevioribus 2–2.5 mm. longis necnon legumine saepissime magis inflato tantum separanda. Ab *O. obnapiformi* (leguminis forma nostram simulanti) pube, foliolis minus numerosis et praesertim legumine stipitato longius villoso abhorret. *O. obnapiformis* C. L. Porter, Madroño 9:133. 1947, pro minori parte.

Similar to var. *Besseyi;* leaflets 7–15, not closely set along the rachis, 10–22 mm. long; scapes surpassing the leaves; racemes 11–19-flowered, somewhat elongate in fruit, the axis becoming 2.5–5.5 cm. long; calyx silky-pilose with appressed or a few looser but strictly ascending hairs, not spreading-hirsute, the tube 6.5–8 mm., the teeth 2–2.5 mm. long; keel about 15 mm. long; pod turgid to strongly inflated, the body ovoid to oblong-ovoid, 7–13 mm. long, 4.5–7 mm. in diameter, abruptly passing into the laterally compressed beak; seeds 2.3–3 mm. long, sometimes faintly mottled. *Type:* mouth of Shell Creek, Big Horn Mountains, Big Horn County, Wyoming, alt. 4,350 ft., 16 June 1946, *Ripley & Barneby 8010,* in Herb. Calif. Acad. Sci. *No. 343211;* isotypes GH, US, WYO.

Distribution: Sandy clay slopes and barren hilltops, mostly on sandstone, in the western foothills of the Big Horn Mountains, west to the Big Horn River, Wyoming. Map 6.

Specimens examined: WYOMING. Five Springs Falls, Big Horn County, *L. & R. Williams 3314* (NY, WTC). 2 mi. s. of Kirby, Hot Springs County, *Ripley & Barneby 8001* (CAS).

The collections on which the present variety is based have given rise to some confusion. The two gatherings from Big Horn County are alike in their strongly inflated, obliquely ovoid pods, and were referred by Porter to *O. obnapiformis,* from which the developed stipe of the fruit, the type of pubescence, and other characters of less moment (cf. discussion of *O. obnapi-*

formis, below) separate them. On the other hand they are ultimately distinguished from typical *O. Besseyi* only by the lack of hispid hairs on the calyx, a character which recurs in *O. Besseyi* var. *salmonensis,* by the slightly shorter calyx-teeth, and by the more pronounced inflation of the pod-valves. The last character is invalidated, however, by the plant from Kirby, cited above, in which, although the calycine peculiarities remain, the pod is no more turgid than in the common state of var. *Besseyi.* The var. *fallax* stands in the same relationship to var. *Besseyi* as does var. *salmonensis* to var. *ventosa,* a small but apparently established race of the pleiomorphic *O. Besseyi* representing the species in the Big Horn Basin.

13. **Oxytropis obnapiformis** C. L. Porter

Oxytropis obnapiformis C. L. Porter, Madroño 9:133, fig. 1, 1947, pro max. parte.

Densely cespitose, with a stout taproot and multicipital caudex, the full-grown tufts composed of upward of 50 crowns; herbage densely white, silky-pilose, and, especially when young, subtomentose with fine flexuous basifixed hairs; stipules membranous, becoming chartaceous and persistent, ovate, 12–20 mm. long, at first shortly connate opposite the petiole but early ruptured, the free blades broadly deltoid-acuminate, 4–7 mm. long, the whole densely and permanently pilose-tomentose, the margins copiously ciliate; leaves 6–20 cm. long, the firm, basally long-persistent petiole and rachis silky-tomentose and ascending-pilose with some longer hairs; leaflets (7) 13–25, often distant and somewhat scattered, lanceolate or lance-oblong to oblong-elliptic, obtuse or acutish, 6–18 mm. long, commonly conduplicate and falcate, rarely becoming greenish in age; scapes erect and ascending, 6–13 cm. long, surpassed by the leaves; racemes 8–22-flowered, dense at first anthesis, becoming looser, the fruiting axis 2.5–8 cm. long; bracts lanceolate, somewhat involute at base, 5–8 mm. long, densely silky-pilose dorsally; calyx 10–11 (13) mm. long, silky with subappressed pale hairs, the deeply campanulate submembranous tube 7.5–8 (9.5) mm., the broadly lanceolate herbaceous teeth 2.5–3 (4) mm. long; petals brilliant pink-purple with a pale striate eye in the banner; banner 18–21 (25) mm. long, the blade oblong, somewhat fiddle-shaped, shallowly emarginate, 9–10 mm. wide; wings 16–20 mm. long, the blades obliquely dilated upward, 5–5.5 mm. broad near the obliquely truncate or emarginate apex; keel 14.5–17 mm. long, the blades, including the straight appendage, 8–10 mm. long; pod sessile, strongly inflated, the body ovoid to subglobose, 5–8 mm. in diameter, gently obcompressed and sulcate ventrally, abruptly narrowed above into a deltoid-acuminate, laterally compressed, straight or slightly declined beak 4–8 mm. long, the valves chartaceous, stramineous when mature, densely gray-villous with ascending hairs about 1 mm. long, produced inward along the ventral suture as a flange 1.8–2 mm. wide; seeds olive-brown, 1.8–2 mm. in diameter.

Type collected by C. L. Porter, in 1946, 8–9 miles west of Maybell . . . Moffat County, Colorado; *C. L. Porter 3864* (RB, isotype) ![6]

Distribution: Sandhills and sandy bluffs between 5,900 and 6,400 feet altitude along the Yampa and Green rivers in northwestern Colorado and adjacent Utah. Map. 6.

Specimens examined: UTAH. Sheep Creek Canyon, Daggett County, *L. O. Williams 9159* (GH, NY). COLORADO (all Moffat County). 4 mi. e. of Maybell, *Ripley & Barneby 9155* (CAS, GH, NY, POM, US, WTU, WYO). W. of Sunbeam, *Ripley & Barneby 9156* (CAS, WYO). S. of Lay, *Ripley & Barneby 9159* (CAS, NY, WYO).

Oxytropis obnapiformis is evidently related to *O. Besseyi,* finding a close resemblance, on account of the inflated pod, in *O. Besseyi* var. *fallax,* material of which was referred to it in the original description. The principal points of difference may be summarized. The vesture of *O. obnapiformis* is composed of finer and mostly shorter hairs, the scapes and young herbage thus becoming subtomentose rather than appressed-pilose, a quality difficult to describe or define, but striking in the field. The leaflets are decidedly more numerous, in developed leaves 13–25 as opposed to 7–13 in var. *fallax.* The scapes are prominently shorter than the leaves, so that the fruiting racemes scarcely emerge from the tufted foliage. The spreading hairs on the pod are only about half as long; while the pod itself is perfectly sessile on the receptacle, and lacks the stipe so evident in forms of *O. Besseyi* with similarly inflated pod and subappressed-pubescent calyx. The seeds of *O. obnapiformis* are appreciably smaller.

In sum, these are not strong characters, and perhaps of no more than subspecific value, especially so since typical *O. Besseyi* may have a subsessile pod and as many as 21 leaflets (but the pod then no more than turgid and the calyx hispid-pilose). Nonetheless the geographic isolation of *O. obnapiformis,* once the var. *fallax* element from the Big Horn Mountains is shifted to *O. Besseyi,* is impressive, and the species is probably best left to stand as such.

The Williams collection from Utah is in flower only, and hence determined with some doubt. The pubescence is that of *O. obnapiformis,* but the flower is more ample, with banner up to 25 mm. long, larger than anything yet known from Colorado. However the keel of the same corolla is 15 mm. long, within the observed limits of true *O. obnapiformis,* and the long banner is probably not important. One plant of this same collection is remarkable in having bracteolate calyces, a monstrous, or at least anomalous occurrence in *Oxytropis.* One further specimen doubtfully referred here is similar to the last, and likewise in flower only. It is mounted on a sheet labelled "Laramie Hills, *B. C. Buffum 41*" (NY) along with a small plant

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[6] The type is at WYO, and numerous isotypes have been distributed to the leading American Herbaria; cf. Porter, l. c.

of *O. Lagopus* var. *atropurpurea.* The latter is not uncommon in the neighborhood of Laramie, and the label probably belongs with it alone. The origin of the other remains uncertain.

14. **Oxytropis viscida** Nutt.

Acaulescent, the leaves and scapes clustered on the pluricipital root-crown, or on the divisions of a forking caudex; stipules membranous, pale, connate at first but early ruptured, 6–20 (26) mm. long, densely pilose to glabrate dorsally, the margins ciliate, the deltoid to caudate-acuminate free blades 3–10 (15) mm. long; leaves 2–23 cm. long, the primary shorter than the rest, the petioles and rachis copiously to thinly villous, sparingly appressed-pilose, or glabrate; leaflets 19–39 or rarely more, diminishing upward, subopposite or rarely geminate and pseudo-verticillate, closely approximate or distant, ovate, oblong-lanceolate, acute or obtuse, 1.5–17 (22) mm. long, 1–5 (6) mm. broad, glabrate or glabrous on one or both (particularly the lower) surfaces, glandular and often verrucose (but the warts obscure or lacking in some dried material); scapes strict or ascending, stout or slender, 2.5–25 cm. long, copiously white-villous throughout, or only above, or nearly glabrous save for short, light or dark, pilosulous hairs below the raceme, smooth or verrucose; raceme 3–20-flowered, becoming 0.5–12 cm. long in fruit; bracts lanceolate to lance-ovate, obtuse or acute, 4–13 (20) mm. long, nearly always glabrous dorsally, exceptionally bearing a few scattered pale or fuscous hairs near the ciliate margins, viscid and often verrucose; calyx densely to thinly pilose with long pale loosely appressed or spreading hairs, or with shorter subappressed dark hairs, or with an admixture of both sorts, or the teeth and exceptionally the tube also nearly glabrous, the tube 4–7 mm., the teeth 1–4 (9) mm. long, the lower linear-subulate, the upper sometimes shorter and broader, all commonly glandular-verrucose; petals white, ochroleucous, (the keel purple-maculate or not) or reddish purple (drying bluish), the banner 11.5–19 mm. long, 4–6 mm. wide; wings 10–14 mm. long, the blades oblong to obliquely triangular, 6.5–9 mm. long, variably dilated upward and 2–5 mm. wide near the truncate or emarginate apex; keel 8–11 mm. long, the appendage minute or up to 1 mm. long; pod erect, sessile, ovoid to lance-ovoid or oblong, more or less tumid, the body (6) 8–12 (15) mm. long, (3) 4–5 mm. in diameter, passing abruptly or gradually into a conical to acuminate, erect or divaricate beak 2–7 mm. long, the valves membrano-chartaceous, strigulose to thinly short-pilosulous with pale, dark or mixed hairs, commonly verrucose, semi-bilocular to subbilocular, the septum 0.5–1.5 mm. broad; seeds brown or black, dull, 1.5–1.8 mm. in diameter.

The species of § *Gloeocephala* Bge., represented in America by ***O. viscida*** and its varieties, are closely interrelated, and a study of our forms cannot be more than exploratory until the nature and degree of variation in their

European and Asiatic relatives becomes established. Material for this purpose has not been available, but it may be noted that the characters in the leaflets, corolla, ovules, and pod employed by Bunge, and more lately by Vassilczenko and Fedtschenko in Flora U. R. S. S., to differentiate between *O. foetida* DC., *O. leucantha* (Pall.) DC., *O. Trautvetteri* Meinsh. and *O. anadyrensis* Vass. are unlikely to hold up under scrutiny if those species are as variable as their American relative. It is suspected, moreover, that one or more members of § *Polyadena* Bge., set off only by the presence of geminate leaflets, a phenomenon which crops up occasionally in *O. viscida*, may have to be considered as a further aspect of the wider problem.

In our territory *O. viscida* is unique by reason of its viscid herbage and inflorescence, which commonly exhale a pleasant resinous fragrance when fresh. The glandular quality sometimes becomes obscure in dried specimens, but a few glandular warts are nearly always to be found on the axis of the raceme, the calyx-teeth, or the pod. Failing these, the glabrous or nearly glabrous bracts provide a convenient and almost infallible character. The species is highly variable in stature, vesture, color of the petals, and other ways but the forms run together in such bewildering fashion that no firm basis has yet been found for maintaining as species the several currently accepted segregates. Three main geographic races, each embracing a number of minutely distinguishable populations, can be made out, but even these are linked by intergradient individuals.

KEY TO THE VARIETIES OF O. VISCIDA

1. Petals relatively narrow, the blades of the wings little dilated upward, 2–3 mm. wide at apex or, if up to 4 mm. wide, then the raceme becoming oblong and loose in fruit; leaflets usually numerous, 25 or more in the secondary leaves or, if less, then the calyx-teeth less than 2 mm. long........ 2

— Petals ample, the blades of the wings dilated upward and 3.5–5 mm. wide at apex; raceme nearly always subcapitate, the axis 1–2 (2.5) cm. long in fruit; leaflets rarely exceeding 25 in number. Alaska (and Siberia)........ c. var. *subsucculenta*

2. Scapes (except in depauperate individuals) 6–25 cm. long, if less than 8 cm. long then the calyx-teeth 2 mm. long or more and prominently verrucose. Alaska to California, Colorado, Minnesota and Quebec (Gaspé)........ a. var. *viscida*

— Scapes 2–8 cm. long; calyx-teeth 1–1.5 (rarely 2) mm. long. Arctic and subarctic, Mackenzie to Hudson Bay........ b. var. *hudsonica*

14a. **Oxytropis viscida** Nutt. var. **viscida**

Oxytropis viscida Nutt. ex T. & G., Fl. N. Amer., 1:341. 1838. *O. campestris* (L.) DC. var. *viscida* (Nutt.) Wats., Bot. King, 55. 1871. *Spiesia viscida* (Nutt.) O. Kze., Rev. Gen., 206. 1891. *Aragallus viscidus* (Nutt.) Greene, Pittonia, 3:211. 1897. *Astragalus viscidus* (Nutt.) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937.

Oxytropis mollis Nutt. ex Gray, Proc. Amer. Acad., 6:235. 1864, in syn.

Aragallus viscidulus Rydb., Mem. N. Y. Bot. Gard., 1:253. 1900. *Oxytropis viscidula* (Rydb.) Tidestr., Cont. U. S. Nat. Herb., 25:332. 1925.

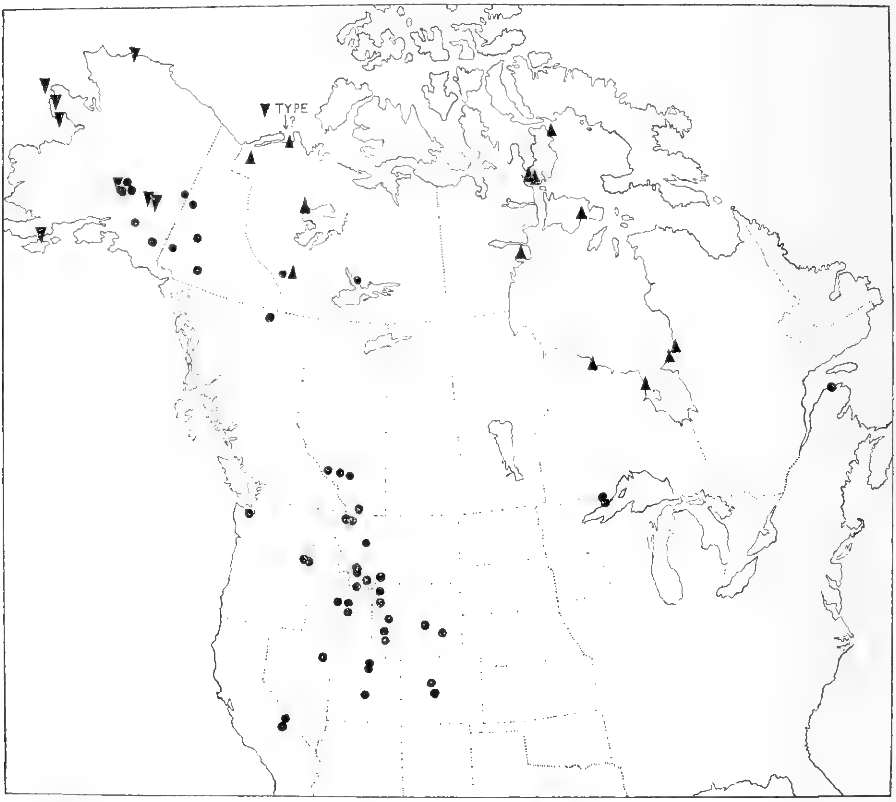
Aragallus viscidulus var. *depressus*[7] Rydb., Mem. N. Y. Bot. Gard., 1:523. 1900.

Oxytropis gaspensis Fern. & Kels., Rhodora, 30:123. 1928. *Astragalus gaspensis* (Fern. & Kels.) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937 (non *A. gaspensis* Rouss., 1933).

Oxytropis ixodes Butters & Abbe, Rhodora, 45:2. 1943.

Oxytropis ixodes fma. *ecaudata* Butters & Abbe, op. cit., 4. 1943.

As described for the species, but the longest leaves rarely less than 8 cm. or the scapes less than 6 cm. long; leaflets commonly scattered, rarely geminate in some of the leaves, (19) 25–39 or more; racemes usually narrow, the axis (1) 2–7 cm. long in fruit; calyx-teeth 1.5–3.5 (4.5) mm. long, permanently and prominently verrucose, as also the pod and often the



Map 7. Range of *Oxytropis viscida:* var. *viscida* ●; var. *hudsonica* (in Mackenzie largely after Porsild and Raup) ▲; and var. *subsucculenta* (in America) ▼.

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[7] This name was written as a straight trinomial, without indication of category; but in the preface to the volume (p. xi) Rydberg referred to "varieties."

herbage; corolla whitish with concolorous or maculate keel, lilac or bright purple, the petals narrow, the wings 2–3 (4) mm. wide at apex. *Type* collected by Thomas Nuttall, in 1834, in the Rocky Mountains, near the sources of the Oregon, i. e. southwestern Wyoming; "R. Mts., Oregon," *Nuttall* (NY, PH)!; "R. Mts." *Nuttall* (GH, as *"O. mollis")!*

Distribution: Alpine crests, talus slopes, or dry hillsides, in the Rocky Mountains either above or below timberline, sometimes among sagebrush or in meadows, Alaska to Colorado, Washington (Olympic Mts.) and transmontane California (s. Sierra Nevada), with outlying stations on the Minnesota-Ontario border, and on Gaspé Peninsula, Quebec. Map 7.

Representative specimens: ALASKA. Teklanika Valley flats, *A. & R. Nelson 3582* (GH, NY, US, WTC, WTU). BRITISH COLUMBIA. Upper Liard River, *Dawson 2* (GH). ALBERTA. Basin, *Stewardson Brown 41* (GH, NY). ONTARIO. Thunder Bay District, *Butters, Abbe & Burns 682* (MINN, type of *O. ixodes* fma. *ecaudata,* GH). QUEBEC. Mont St. Pierre, Gaspé County, *Fernald & Smith 25874* (GH, type of *O. gaspensis,* CAS, NY), *Fernald & Weatherby* in *Pl. Gray. Exsicc. No. 560.* WASHINGTON. Mt. Angeles, Clallam County, *J. W. Thompson 8399* (CAS, NY, US, WTU). OREGON. Wallowa River, Wallowa County, *Cusick 2320* (GH, ND, WTC). IDAHO. Arco, Butte County, *Macbride & Payson 3097* (CAS, GH, NY, POM, US). MONTANA. Red Hill, Madison County, *C. L. Hitchcock 16928* (RB, WTC, WTU). Melrose, Silver Bow County, *Rydberg 2716* (NY, type of *A. viscidulus).* Haystack Mt., Stillwater County, *Tweedy 120* (NY, type of *A. viscidulus depressus), Hitchcock & Muhlick 13399* (CAS, RB, US, WTC). MINNESOTA. South Fowl Lake, Cook County, *Butters, Abbe & Burns 611* (MINN, type of *O. ixodes,* GH). WYOMING. Laramie Peak, Albany County, *A. Nelson 7519* (GH, NY, POM, US). Between Eden and Big Piney, *E. & L. Payson 2584* (GH, NY, POM, US). Wind River, Fremont County, *Parry 89* (GH, NY). Yellowstone Park, *Parry 87* (GH[8]). NEVADA. East Humboldt Mts., *Watson 292* (GH, NY, US). UTAH. Clear Creek Pass, Mt. Hilgard, Sevier County, *Eggleston 10360, 10361* (US). COLORADO. South Park, Park County, *Wolf 352* (GH, UC, US). CALIFORNIA. Thunder and Lightning Lake, Inyo County, *J. T. Howell 23988* (CAS, RB).

Oxytropis viscida is extraordinarily variable in aspect and detail and seems to be in process of fragmentation. Material from almost any given station or restricted region has a more or less distinctive appearance, probably genetically controlled. But when the diversity is analyzed, it is found to consist of an interchange of rather few and in the genus trivial characters, no one of them unique to any single race but combined in various ways. The strictly typical phase, as collected by Nuttall and known from a few

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[8] Parry's *Nos. 87 and 89* are labelled "N.-W. Wyoming," but cf. Jones, Rep. Reconn. N.-W. Wyo., 310. The first collection formed part of the original *O. monticola* Gray; cf. discussion of *O. campestris* var. *gracilis,* below.

other collections from Wyoming, has the scape and inflorescence copiously white-villous, the stipules strongly pilose dorsally as well as ciliate, and small whitish flowers, with immaculate keel 8–9 mm. long. In western Wyoming a white-villous form occurs in which heavily pubescent stipules are combined with purple flowers, or with ochroleucous banner and maculate keel. And this passes gradually into the state known as *Aragallus viscidulus,* in which the flower is, or may be, somewhat larger (the keel 9–11 mm. long), the corolla bright purple, the calyx and whole inflorescence either dark-strigose, fuscous-pilose or dark-strigose with an admixture of longer and looser pale hairs. Here the scapes may be appressed-pilose, or glabrate, and the stipules either pubescent or nearly glabrous dorsally. Rydberg attempted to distinguish *O. viscidula* from *O. viscida* by the absence of yellow hairs on the caudex-branches (meaning their thatch of marcescent stipules), by the shorter, dark vesture of the calyx, scape and pod, and by the more gradually long-acuminate pod. Comparison of the types of these species shows that the stipules are equally pilose in both; while we now have examples of gradually and abruptly acuminate pod combined with either pale or fuscous vesture and with either purple or ochroleucous flowers. Jones (Montana Bot. Notes, 38) has shown how unreliable is the color of the calyx-hairs in *O. viscida,* as it is indeed in most other species. Although Hultén maintained both *O. viscida* and *O. viscidula* in the Flora of Alaska and Yukon, he there admitted (p. 1108) that "the difference between [them] lies merely in the degree of pubescence, and some collections could only be more or less arbitrarily separated into the respective species"; and his maps (nos. 838, 839) show that the areas of the two are not significantly different in Alaska.

The purple-flowered Minnesota plant, *O. ixodes,* was said to differ from *O. viscidula* in its larger and more numerous leaflets, longer broader petals, longer and narrower "sepals," and more deeply sulcate legume. All these features are duplicated somewhere, if not together, in cordilleran material of *O. viscida,* and had the specimens originated in Wyoming, rather than in a station remote from the main area of the species, they would have been referred without doubt or difficulty to that species.

Yet further isolated, on the Olympic Peninsula in Washington, and on Gaspé Peninsula in Quebec, there are two forms of *O. viscida* which have somewhat better claim to recognition. The first has a pale and immaculate corolla, and the vesture nearly of typical "*O. viscidula,*" with dark hairs predominating in the inflorescence, and usually small and closely approximate leaflets. Material of it was referred by St. John (Proc. Biol. Soc. Wash., 41: 103, 1928) to his *O. olympica,* and by G. N. Jones (Univ. Wash. Pub. Bot., 5: 189, 1936) to *O. luteola,* both of which are, strictly speaking, forms of the eglandular *O. campestris.* The viscid *Oxytropis* of Gaspé *(O. gaspensis)* is again pale-flowered, but the keel is maculate, and the other petals are said to be "white changing to pale pink," "pale lilac," or "creamy." Here the scape and inflorescence are thinly white-villous, the vesture similar in quality to that of Nuttall's *O. viscida,* but the calyx-teeth (1.5–2 mm. long) are shorter than in nearly all cordilleran forms, whether white or purple-flowered.

The populations of the Olympics, Minnesota, and Gaspé, evidently relicts of a wide pre-glacial distribution, present a special problem. If held distinct, they are actually or very nearly spot endemics, *O. gaspensis* confined to the flanks of a single mountain, *O. ixodes* to two slate talus slopes a few miles apart (it has been reported from District of Mackenzie; cf. Sargentia, 6:209), and the Olympic race to a single ridge in that range (and perhaps the Wallowa Mts., Oregon, whose local race is closely similar). In their restricted ranges they remain nearly monomorphic and are not *precisely* like anything from the main area of variable *O. viscida.* At the same time there are many small races of *O. viscida* isolated on mountain peaks or on dry knolls in the foothills of the Rocky Mountains which differ among themselves to as great a degree and in the same or equivalent directions. These also can be considered spot endemics, for their individual isolation (as on the East Humboldt Mts., Nevada, for example) is as complete, even though far less dramatic, as that of *O. gaspensis.* Just as *O. ixodes* in the type-locality differs from that in the nearby Canadian station (fma. *ecaudata)* in the length of the stipule-blades, so do little races of *O. viscida* from neighboring mountain ranges in the West differ, with apparent constancy, in length of keel, incidence of dark or light, spreading or appressed hairs, length of legume, and other details. Once the combination presented, for example, by *O. gaspensis,* is accepted as of taxonomic importance, it is inconsistent to pass over other combinations of equivalent value. Montana and Wyoming alone harbor half a dozen entities of the order of *O. gaspensis.* Rather than attempt such minute discrimination, which is bound to be reduced at length into extremes of "Jordanism," it has seemed prudent to demote *O. gaspensis, O. viscidula,* and *O. ixodes* to the rank of minor variants.

Typical *O. viscida* fluctuates between a mesophytic extreme from moist meadows, with ample thin leaflets, long scapes, and open fruiting racemes, and a reduced subalpine state *(Aragallus viscidus depressus)* in which the leaflets are fewer, thick, and crowded, the scape short (as little as 3 cm. long) and the raceme few-flowered and subumbellate. This dwarf plant simulates and nearly approaches var. *hudsonica,* from which it is distinguished principally by its longer and prominently verrucose calyx-teeth. And some plants from high latitudes (e. g. *Kusche in 1916,* from Whitehorse, Yukon, CAS, which includes individuals with abbreviated and longer teeth in the same collection) are quite intermediate in this respect.

Oxytropis viscida is closely related to the vast and variable *O. campestris,* and hybridization often occurs where the two species come into contact. On

Hurricane Ridge in the Olympic Mountains, the white-flowered local form of *O. viscida* is associated with *O. campestris* var. *gracilis,* and several collections have been seen which are intermediate between them in some characters. The var. *gracilis* is devoid of glands and, in this station, its leaves and bracts are copiously appressed-silky, in contrast to the viscidity, sparse and looser vesture, verrucose calyx-teeth, and dorsally glabrous bracts of the other. Specimens intermediate in pubescence and combining sparsely pilose bracts with glandular calyx-teeth are pretty certainly of hybrid origin (cf. Hurricane Ridge, *G. N. Jones 3219, 4015,* WTU). Similarly in the foothills of the Alberta Rockies there is a peculiar plant which perhaps springs from crosses between *O. viscida,* always purple-flowered in that area, and the form of *O. campestris* var. *gracilis* with some geminate leaflets. The extraordinary similarity between such purple-flowered plants from Bow River west of Calgary *(Moodie 143,* NY), with a few geminate leaflets, subglabrous bracts, and verrucose calyx-teeth, and those from Banff *(Butters & Holway 14,* GH, NY) or Brazeau *(Stewardson Brown 1062,* NY), differing only in the lack of warts or apparent viscidity, could be conveniently explained by assuming that the first, otherwise pure *O. viscida,* has inherited its paired leaflets and some hairs on the bracts from var. *gracilis,* while the others, otherwise quite like the prevailing var. *gracilis* of the region, have derived their purple flowers from *O. viscida.* The Alaskan plants quoted by Hultén (Fl. Alaska and Yukon, 1109) as having "glandular calyx-teeth and a tendency to verticillate leaflets," not seen by the writer, could represent a cross involving *O. campestris* var. *varians.* It is equally possible, however, that a potentiality for paired leaflets exists in the species as a whole. It is difficult to accept the theory of hybridization in the case of the remarkable plants from Colorado (Dillon, *Eggleston 11952,* US; Blue River, n. of Breckenridge, *Ripley & Barneby 10468,* CAS, NY, WYO), among which are found some of the most extreme examples of paired leaflets yet encountered in *O. viscida;* for the requisite other parent (unless it is here *O. splendens,* which seems highly improbable) does not range so far south. The eglandular plant with some geminate leaflets from Alberta closely matches specimens in the herbaria of Gray and Torrey received from Hooker as "*O. Lambertii β,*" and doubtless represent that variety as treated in Flora Boreali-Americana and in Torrey and Gray's Flora. When Bunge wrote of *O. Lambertii:* "foliola . . . saepe quaternatim verticillata," he was probably referring to part of this collection, presumably taken by Drummond in Alberta. In the herbarium of the New York Botanical Garden it was found that Rydberg had set aside "*O. Lambertii β*" (eglandular) and *Moodie 143* (glandular) in a species-cover under an unpublished name commemorating Drummond; probably he intended to publish a species based on these specimens. But the true status of this most interesting form is still to be established. The glandular state is illustrated in S. Brown, Alp. Fl. Canad. Rocky Mts., opp. p. 176, 1907.

14b. **Oxytropis viscida** Nutt. var. **hudsonica** (Greene) Barneby

Oxytropis viscida Nutt. var. *hudsonica (Greene)*, stat. nov. *Aragallus hudsonicus* Greene, Proc. Biol. Soc. Wash., 18:17. 1905. *Oxytropis hudsonica* (Greene) Fern., Rhodora, 30:142, Pl. 172, both upper and lower figs. 1928.

Similar to var. *viscida* but low, the leaves 2–6 (10) cm., the scapes 2.5–7 cm. long, the latter sparsely villous-pilose; leaflets 19–33, 1.5–6 mm. long; racemes densely 3–9 (16) -flowered, the axis scarcely exceeding 1 cm. long in fruit; calyx pilose with fuscous or rarely pale hairs, 7.5–8 mm. long, the tube 6–6.5 mm., the deltoid-subulate teeth 1–1.5 mm. long, not or quite obscurely verrucose; corolla "reddish-purple"; pod not or obscurely granular-verrucose, short-pilosulous with light or dark hairs. *Type* collected by A. P. Low, in 1896, at Whale River, Hudson Bay; *Low 14272* (ND)!

Distribution: Arctic and subarctic shores around Hudson Bay, north to Melville Peninsula, eastward to Great Bear Lake and the Mackenzie Mountains. Map 7.

Representative specimens: Mackenzie. Great Bear Lake, *Bell 22895* (GH). Keewatin. Ranken Inlet, *J. Macoun 79104* (NY). Franklin. White I., Frozen Strait, *Angel 51, 53* (US). Ontario. James Bay, *R. H. Smith 89* (US). Quebec. N. of Cape Jones, Hudson Bay, *Low 63166* (GH, NY).

The var. *hudsonica* is closely related to var. *viscida*, differing principally in its diminished stature, short calyx-teeth and less marked viscidity, the glandular verrucae being almost lacking, or from the calyx-teeth completely so. None of these characters is of itself absolutely diagnostic, but together they mark a distinctive population of eastern Arctic and subarctic distribution. Like var. *viscida*, it is variable in flower-size, in the number of flowers to the raceme, and in the color of the pubescence, the calyx varying from fuscous to white-pilose. The leaflets may be nearly glabrous, with a few scattered hairs on the elevated margins, or loosely pilose on both sides; but the lower surface is commonly less hairy than the upper and, as in most of var. *viscida*, corrugated when dry.

Reports of var. *hudsonica* from Alaska, as pointed out by Raup (Sargentia, 6: 207, Pl. xxx [map], 1947), are based on misidentifications; and the western limit of the variety has not been clearly determined. Porsild (Sargentia, 4: 53, 1943) cited several collections from the Mackenzie Delta region, and Raup had both var. *hudsonica* and *O. ixodes* (presumably a form of var. *viscida)* from Brintnell Lake in southwestern Mackenzie. But this material has not been seen.

The little plant labelled "Melville Island" (GH, without collector's name) which was illustrated by Fernald (Rhodora, 30, Pl. 172, 1928) as

O. arctica has dorsally glabrous bracts and thick, sparingly pilose leaflets. If this is really the plant described by Robert Brown from Melville Island, the name *arctica* is misapplied in this paper. However the description of *O. arctica* in Chloris Melvilleana calls for a sericeous plant, with 11–17 leaflets (so described by Fernald, also op. cit., p. 144), whereas the subject of the photograph is glabrescent and, as a glance reveals, the leaflets are 21 or 23 to the leaf. Note also the striking similarity between the supposed "*arctica*" and the isotype of *Aragallus hudsonicus* side by side on the cited plate. They are surely conspecific, and *O. arctica* is something else again. The origin of this controversial specimen, which Fernald described as a duplicate type of *O. arctica*, is quite doubtful in spite of the fact that it is labelled "Melville Island." Polunin (Bot. Canad. E. Arct., 292, 1940) pointed out that some of the plants from Parry's explorations (of which this is probably one) are not from the First Voyage and therefore must have come from points far south and east of Melville Island, in the region of Hudson Strait and Melville Peninsula. Very likely this is a case in point. There is no modern evidence of the presence of var. *hudsonica* on Melville Island whereas Polunin noted a specimen of it in the British Museum collected on Pary's Second Voyage at Igoolik Island (Melville Peninsula, at about 69° N.), apparently the most northerly known station.

14e. **Oxytropis viscida** Nutt. var. **subsucculenta** (Hook.) Barneby

Oxytropis viscida Nutt. var. *subsucculenta* (Hook.), comb. nov. *O. uralensis β subsucculenta* Hook., Fl. Bor.-Amer., 1:146. 1831.

Astragalus leucanthus Pall., Astrag., 59, Pl. 47. 1800. *Oxytropis leucantha* (Pall.) Pers., Syn., 2:331. 1807. *Spicsia leucantha* (Pall.) O. Kze., Rev. Gen., 206. 1891. *Aragallus leucanthus* (Pall.) Greene, Pittonia, 3:211. 1897.

Oxytropis borealis DC., Prod., 2:273. 1825.

Oxytropis borealis β H. & A., Bot. Beechey Voy., 122. 1832.

Oxytropis campestris var. *verrucosa* Ledeb., Fl. Ross., 1:591. 1842.

Usually low, the leaves 7–10 cm., the scapes 4–12 cm., rarely up to 18 cm. long; leaflets 19–25 (37); inflorescence and upper part of the scapes densely hirsute with fuscous or mixed black and paler hairs, the longer hairs occasionally lacking below the inflorescence; racemes subcapitately 5–10-flowered, the axis (0.5) 1–2 (2.5) cm. long in fruit; calyx 8–10 (12) mm. long, the tube 5–6 mm., the teeth (2) 3–4 (8) mm. long; petals purple, lilac or whitish, the banner (13.5) 15–18 (22) mm. long, 5.5–7 mm. broad; wings 12.5–15 mm. long, the blades (7) 8–11 mm. long, (3.5) 4–5 mm. wide near the dilated apex; keel 11–13 mm. long, the appendage commonly minute. *Type* collected by Dr. Richardson, on the "Arctic seashore, to the east of the Mackenzie River."

Distribution: Arctic shores, from "Mackenzie" to Behring Strait, south to interior Alaska and Alaska Peninsula, and westward from Okhotsk Sea to the Aldan River, Siberia. Map 7.

Representative American specimens: Alaska. Castner Glacier, Alaska Range, *A. & R. Porsild 495* (GH). Alalaqoqshuk Mt., Katmai Nat. Mon., *Henning 516* (US). Nome, *Grace Hill 104* (US). Point Lay, *Mason in 1931* (CAS, UC).

The relatively few leaflets, ample flowers, and condensed, copiously hirsute inflorescence combine to make var. *subsucculenta* striking to the eye, but it seems scarcely possible to maintain it as a species distinct from *O. viscida* on substantial characters. In fact there is no absolute criterion. In var. *viscida,* as here treated, the calyx-teeth are quite variable, occasionally reaching 4 mm. in length, the leaflets can be as few as 19 in the developed leaves, the wing-petals may rarely be dilated upward and as much as 4 mm. broad (though usually much narrower), and a few examples of densely hirsute raceme have been noted. Gray (Proc. Amer. Acad., 20:5) contrasted the oblong spike, white-hairy calyx, and small puberulent pod of *O. viscida* with the congested raceme, dark-hairy (in spite of one instance of white-hairy) calyx, and larger black-villous pod of "*O. leucantha.*" While the length of the raceme still appears to be a rather stable character, the color of the hairs is without value, the very type of var. *subsucculenta* being white-hairy. Little good fruit of var. *subsucculenta* (or *O. leucantha)* has been available for comparison, but the few pods examined seem quite similar in all respects to that of var. *viscida,* itself most variable in length, in development and direction of beak and style, and in color and density of vesture.

The epithet *subsucculenta* has been taken up for the *O. leucantha* of most authors on the basis of data most kindly contributed by Mr. N. Y. Sandwith, of the Royal Herbarium, Kew Gardens. At the writer's request Mr. Sandwith examined the type at the British Museum, labelled "*O. uralensis β*" in Hooker's hand[9], and found it to be a glandular plant, with calyx-tube 7 mm. and verrucose teeth averaging 3 mm. in length. These dimensions of the calyx rule out the possibility that the plant can represent var. *hudsonica,* which the type-locality, "arctic sea-coast," might otherwise suggest; and the "fine head of beautiful big flowers," as described by Sandwith, as well as smaller details of his description, point to what is known to American botanists as *O. leucantha.* Although we have no modern record of the variety from east of the Mackenzie Delta, there is also no reason to believe that var. *viscida* extends north of the Arctic Circle. Unless there is a fourth glandular *Oxytropis,* otherwise unknown to the writer, in boreal America, the identity of *O. leucantha* and *O. uralensis β subsucculenta* seems established.

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[9] A copy of Mr. Sandwith's extensive notes has been deposited in the herbarium of New York Botanical Garden.

In the absence of pertinent types it is best to follow Bunge's disposition of *Astragalus leucanthus, Oxytropis borealis,* and *O. campestris* var. *verrucosa* as synonyms. Only one viscid member of the genus is known from the environs of Behring Strait, so that var. *verrucosa*, described as "undique . . . verrucis vel tuberculis subnigricantibus . . . dense obtecta," can be applied with some assurance to the plant on the American side. Bunge expressly referred var. *verrucosa,* as well as Wright's collection of var. *subsucculenta* from Arakamtchtchene Island (GH, US) to *O. leucantha,* and there can be little doubt as to their identity.

The reduction of *O. borealis* is taken on faith from Bunge and is of interest here only in so far as the name was tentatively applied by Fernald to an eglandular plant of coastal Mackenzie (cf. discussion of *O. campestris* var. *varians,* below). The species was described by DeCandolle from specimens acquired from Fischer and is said to have originated, like the type of var. *verrucosa,* "in terra Tschuktschorum ad sinum Sancti-Laurentii"; the collector is not stated. The description in the Prodromus fails to note viscidity or glands, but otherwise fits var. *subsucculenta* well. Ledebour (Fl. Ross., 1:191) stated, on the authority of Schrenk who had seen DeCandolle's type, that *O. borealis* was a synonym of *O. campestris* var. *sordida,* an eglandular plant of Arctic Europe which probably reaches its eastern limit in Novaya Zemlya; but this seems nearly impossible. Since Bunge inferred that he had seen authentic material of *O. borealis* in Fischer's herbarium, and reduced it without comment to *O. leucantha,* there is no reason to question the opinion of the monographer, accepted by Gray and lately confirmed by Vassilczenko and B. Fedtschenko in Flora U. R. S. S.

15. **Oxytropis campestris** (L.) DC.

Oxytropis campestris (L.) DC., Astrag., 59. 1802. *Astragalus campestris* L., Sp. Pl. 761. 1753, sensu ampliatissimo.

Very variable in stature and pubescence, green and glabrate to densely silky-pilose, or sometimes villous-hirsute, especially as to scape and petiole; stipules membranous, pale, glabrous to pilose dorsally, the free blades triangular to lance-acuminate, 1--3-nerved, the margins naked or ciliate with bristles and rarely with clavate processes; leaflets 7–45, scattered, opposite, or sometimes geminate and pseudo-verticillate; scapes decumbent or erect, 2.5–30 cm. long; bracts pilose dorsally, very rarely glabrate; racemes 5–30-flowered, capitate to oblong, sometimes much elongating and narrow, 0.5–11 cm. long in fruit; calyx loosely pilose with pale, fuscous, or commonly mixed hairs, the tube (4) 4.5–7 mm., the teeth 1–4 mm. long; corolla white, ochroleucous, pale yellow, purplish or bright purple; banner 12–20 mm. long, 4–8 (9) mm. wide; wings 10–17 mm. long, the obliquely oblong, truncate or emarginate blades usually not much dilated upward, (1.5)

3–4.5 (6) mm. wide at apex; keel (9) 10–15 mm. long, the appendage commonly small; pod sessile or nearly so, strict or somewhat spreading, the oblong to obvoid-ellipsoid, somewhat tumid body (5) 8–16 mm. long, passing into a straight or variably divaricate beak about 5 mm. long, the valves membrano-chartaceous, not rigid, shortly pilosulous, the ventral suture inflexed to traverse half or nearly the whole width of the cavity, the dorsal suture filiform or rarely raised within as a narrow and incipient septum.

From the earliest days of botanical exploration in North America the name *O. campestris* has figured in the literature. For the most part the plants of the New World have been held varietally distinct from the Linnaean *Astragalus campestris,* but the belief that true *O. campestris* is native, at least in high latitudes, has found expression as lately as 1943. In 1871 Watson (Bot. King, Append., 447) recorded *O. campestris* as ranging from the Arctic to Maine and Colorado; and three years later Bunge (Gen. Oxytr., 107) accepted the species as west European, east Asian (to Sakhalin) and western North American, noting however that the latter, "robustiore, elatiore, racemo dissitifloro" differed somewhat in stature and habit. The purple-flowered plants of eastern North America were doubtfully referred by Bunge to *O. sordida* (Wahlenb.) Pers., an Arctic European species which has been widely and no doubt correctly regarded as a variety of *O. campestris.* Gray's second revision (1884) excluded typical *O. campestris* from the American flora for the first time, the material which had been so named hitherto being divided between a western Arctic "*O. leucantha*" (at the time an imperfectly known entity), a purple-flowered eastern *O. campestris* var. *coerulea* (the *O. sordida* of Bunge), and a new species, *O. monticola,* largely cordilleran and ochroleucous-flowered. Fernald has since shown that behind Gray's var. *coerulea* (not var. *coerulea* Koch) there lurked two perfectly distinct endemic entities, *O. johannensis* and *O. terrae-novae,* and went far to explain the idea of an arctic *O. campestris* or *O. campestris* var. *melanocephala* of early authors. During the present century the far Western and Rocky Mountain forms have been elaborately segregated by Aven Nelson, Greene, Rydberg, St. John, and others, until we now have more or less current in floristic or monographic works no less than fourteen species in an area where Watson could see only *O. campestris* and Gray only *O. monticola.*

The foregoing summary of the literature will suffice to show that a return to the concept of an American *O. campestris* is by no means a revolutionary step. While it is argued here that *O. campestris* in its original and narrowest sense is, as Gray and most modern botanists have concluded, absent from the New World, nevertheless the European and American plants can reasonably be ranked as geographic populations within a polymorphic, circumboreal species. These races, treated below in the category of varietas, are alike in flower and, except for the occasional production

Table I. Variation in some critical organs of American O. campestris.

	Campestris (European)	Varians	Alaskana type	Gracilis	Villosa (type)	Luteola (& *olympica*)
STIPULES						
p[ilose], gl[abra]te or gl[abrous] dorsally	p, gte	p, gte	p	p. gte	thinly p	thinly p, gte
length of free blades (in mm.)	2–12	2–8	8–12	3–12	ca. 6	3–11
margins g[labrous], c[iliate], or bearing glandular p[rocesses]	g, or c, p	c, p	c, p	g, or c	c	± c
LEAVES						
length (in cm.)	6–20	3–21	7–17	6–20	7–11	4–17
number of leaflets	17–33	13–45	19–25	17–33	23–29	17–25
length of leaflets (in mm.)	4–16	2–24	5–20	3–23	7–13	4–16
SCAPES						
app[ressed-pilose] or spr[eading-pilose]	app or spr below	app, spr	spr	app or spr below	spr	app or spr below
length (in cm.)	6–20	3.5–24	15–20	7–30	8–13	9–16
RACEMES						
number of flowers	5–12	6–25	15	6–30	12–18	7–16
length of fruiting axis	1–4	0.5–10	1–3	2–10	ca. 3	1–5
CALYX						
length (in mm.)	7–9	6–8	7.5	7–10	7.5	6.5–9.5
tube (in. mm.)	5.5–6.5	4–6	5.5–6	4.5–7	5.5	5–7
teeth (in mm.)	1–2.5	1.2–3	1.5–2	1.5–3	2	1.5–3
COROLLA						
ochr[oleucous], wh[itish], with mac[ulate keel], p[urple], or p[urpli]sh	ochr or psh	ochr, wh	ochr	ochr, wh, rarely mac	ochr	ochr
banner: length x width (in mm.)	15–20 x 4–6	12–17 x 5–7	15–18 x 6–7	12–19.5 x 4–7	15 x 6	14–19 x 4.5–6
wings: total length x width of blade (in mm.)	13–15.5 x 1.5–4	10.5–15 x 3–4	13–14 x 3.5–4	10–16 x 2.5–4	12 x 3.5	14–16.5 x 2.5–4
keel: length, including appendage (in mm.)	12–14	10–12	12–13	10–14	11.5	13–15
MISCELLANEOUS	pod obscurely septate dorsally	leaflets sometimes geminate		leaflets sometimes geminate	a few leaflets geminate	

Cascadensis (& *Mazama*)	Okanoganea (& *cervinus*)	Columbiana	Dispar	Cusickii (& *Paysoniana*)	Rydbergii	Johannensis	Chartacea	Terrae-novae
gl or glte	densely p or gte at tip	densely p, rarely gte	strongly p	thinly p gte, g	gte	densely p, or gte	densely p	g or gte
4.5–10	4–15	2–7	4–14	2–7	4–8	3–18	4.5–12	2–7
± c	c	c	c	± c, or g	c	c or nearly g	c	sparsely c, or g
5–18	6–23	5–17	5–21	3–12	1.5–7	4–26	8–21	2–13
15–28	13–23	11–17	19–25	7–17	7–13	17–29	21–27	11–27
3–18	7–27	9–30	4–20	4–23	3–11	3–29	5–20	2–10
app	app or spr below	app or spr below	± spr	app	app, rarely spr	app	spr	app
6–21	15–27	13–30	7–18	5–19	2.5–10	4–36	10–25	3–16
6–20	9–22	6–28	8–15	6–15	3–8	7–14	10–20	3–9
1.5–3	5–11	2–10	2–6	1–3 (6.5)	0.5–1.5	1.5–11	2–13	0.3–1.5
7–9	7–9	7.5–10	8–9	7–10	7–9	6–8	6–8	5–7
5–6	4.5–7	5–6.5	6–6.5	5–7	5–6.5	5–6	4–6.5	4.5–6
2–4	1.5–3	2–4	2–2.5	1.5–3	2.5–3	1–3	1.5–2.5	0.5–1.5
ochr	ochr	wh, mac	ochr, wh, mac, p or psh	ochr	ochr (?mac)	p	p	p
14–17 x 5–7	16–18 x 6–9	15.5–20 x ca. 6	17–19 x 6–8	14–20 x 5–8	14–18 x 5–7	12–18.5 x 6–8.5	13–15 x 5–7	11–18 x 4.5–6
11–14 x 2.5–3	14–16 x 2.5–5.5	13–17 x 3–4	14–16 x 4.5–6	11.5–15 x 3–4.5	11.5–15.5 x 3.5–4.5	13–15.5 x 3.5–5.5	11–14 x 4–5	10–15 x 3–4.5
11–13	12.5–14.5	11–14	ca. 13	11–14	11–14	10–13	10–12	9–13

of a vestigial dorsal partition, in structure and texture of the pod. The visible differences, sometimes very great, are matters of stature, number of leaflets, length and density of the raceme, and number and color of the flowers. The type and degree of variation in flower-size and in the orientation or amount of vesture are remarkably uniform throughout the complex, villous-hirsute and appressed-pilose, or large and small-flowered states being encountered in nearly every race of which representative material is available. With a slight shift of emphasis from the superficial differences to the many fundamental similarities the acceptance of an American *O. campestris* becomes inevitable. In order to present more vividly than would be possible in a running account the types of variation noted in this puzzling group of forms, the accompanying table has been compiled. The figures in it are perhaps somewhat casuistic in effect, since the inclusion of unusual extremes tends to mask prevailing tendencies in one or more directions. But in general it serves to express the essential similarity of many "species" which have been subordinated in rank or reduced to synonymy.

The presence of an incipient dorsal septum in the pod of European *O. campestris,* alluded to above, was so highly regarded as a criterion by Bunge that it deserves further comment. In his monograph of the genus Bunge actually separated two sections, *Orobia* and *Diphragma,* by this single character. He himself expressed doubt as to the naturalness of the resulting arrangement, pointing out that some members of *Orobia* seemed to find closer affinities in *Diphragma* than within their own section; and simultaneously he admitted to section *Gloeocephala,* which differs from *Orobia* and *Diphragma* only in having a glandular pubescence, species with both types of legume. The partition in the pod of *O. campestris,* sensu stricto, is extremely narrow and at times may be nearly obsolete, while in our cordilleran plants the dorsal suture of the pod, although nearly always naked and filiform, is occasionally a trifle thickened and elevated within. At this point the pod is inseparable from that of the European plant, and the importance of the character has no doubt been overestimated.

KEY TO THE AMERICAN VARIETIES OF O. CAMPESTRIS

1. Petals white or ochroleucous or, if purple, the leaves strongly dimorphic and the valves of the pod rather firm; west of the 90th meridian and Hudson Bay 2

— Petals (except in an occasional albino) purple; leaves not strongly dimorphic; pod thin-chartaceous; east of the 90th meridian, Wisconsin, Maine and Quebec to Hudson Strait 6

2. Stipules (or at least some of them) bearing clavate processes on the margins of the free blades, these often mixed with bristly ciliae; Alaska to n.-e. Manitoba and n. British Columbia.......... 15a. var. *varians*

— Stipules devoid of clavate processes, the blades glabrous or ciliate; widely diffused in w. North America from the Canadian Rockies southward.......... 3

3. Corolla purple or polychrome (i. e. with flowers of many shades, including white, in the same colony); stipules and herbage densely and permanently pilose; prairies of North Dakota.......... 15d. var *dispar*

— Corolla uniformly white or yellowish, the keel very rarely purple-tipped...... 4

4. Petals concolorous, the keel immaculate or, if maculate, the leaflets more than 17 to the developed leaf, or the scapes low, less than 1 dm. long.......... 5

— Petals white with prominently maculate keel; leaflets 7–17. Robust riparian plants of the Columbia River above the mouth of the Spokane in Washington, and of the Flathead River in n.-w. Montana.......... 15e. var. *columbiana*

5. Leaflets 17–33 in number or, if less, then tall plants of middle elevations in n. Washington and British Columbia with densely silky stipules, or the scapes (except in depauperate individuals) 1.5–3 dm. tall, or the racemes loose and 5–11 cm. long .... 15b. var. *gracilis*

— Leaflets 7–17 in number; low alpine or subalpine plants of the higher Rocky Mountains, the scapes 1.5–15 cm. long; stipules glabrous or glabrate dorsallly; fruiting racemes rarely surpassing 4 cm. in length.......... 15c. var. *Cusickii*

6. Racemes 3–8-flowered, not elongating, the axis 3–15 mm. long in fruit; calyx-teeth deltoid, 0.5–1.5 mm. long; plants low, the scapes usually arcuate-ascending, 3–16 cm. long..........15f. var. *terrae-novae*

— Racemes 7–14-flowered, elongating in fruit, the axis becoming (1.5) 2–11 cm. long in fruit; calyx-teeth commonly lanceolate, (1) 2–3 mm. long; plants more robust, the scapes erect, 10–36 cm. long.......... 7

7. Pod 14–27 mm. long; stipules glabrous to sparingly pilose dorsally; pubescence of the scapes and herbage usually subappressed; Maine to Gaspé and Newfoundland .... 15g. var. *johannensis*

— Pod 8–13 mm. long; stipules more densely pilose dorsally; pubescence of scapes and herbage looser and more copious; Wisconsin.......... 15h. var. *chartacea*

15a. **Oxytropis campestris** (L.) DC. var. **varians** (Rydb.) Barneby

Oxytropis campestris (L.) DC. var. *varians* (Rydb.), stat. nov. *Aragallus varians* Rydb., Bull. N. Y. Bot. Gard., 2:176. 1901. *Oxytropis varians* (Rydb.) K. Schum., Just's Jahresb., 29^1:543. 1903; Hult., Fl. Alaska & Yukon, 1107, map 839. 1947 (as "comb., nov.").

? *Oxytropis alaskana* A. Nels., Univ. Wyo. Pub. Bot., 1:120. 1926.

Oxytropis hyperborea Porsild, Sargentia, 4:53. 1943.

Variable in stature and pubescence, the herbage copiously silky-pilose, or somewhat hirsute, or glabrescent; stipules pilose dorsally, the margins beset with bristly ciliae and some clavate processes; leaves 3–15 cm. long; leaflets (11) 15–45, either scattered, subopposite, or geminate and pseudoverticillate, especially on the secondary leaves; scapes ascending or erect, 3.5–24 cm. long; racemes (6) 10–24-flowered, ovoid to subcylindric at anthesis, the axis becoming (0.5) 2.5–10 cm. long in fruit; calyx pilosulous with black and pale hairs in varying proportions, 6–8 mm. long, the tube 4–6 mm., the teeth (1.2) 1.5–3 mm. long; petals ochroleucous, or rarely yellow, the keel occasionally maculate; banner 13–15 (17) mm. long; wings 12–15 mm. long, the blades 3–4 mm. wide; keel 10.5–12 (13) mm. long.

Type collected by J. B. Tarleton, in 1899, on the Lewes River, Yukon; *Tarleton 33b* (US)!

Distribution: Rocky hillsides, moraines, arctic and subarctic shores, or in meadows along streams, coastal Mackenzie to Alaska, northern British Columbia and northeastern Manitoba (on Hudson Bay). Map 8.

Representative specimens: ALASKA. Yukon River, between Tanana and Rampart, *L. J. Palmer 57* (US)*[10]. McKinley Park P. O. *A. & R. Nelson 3658* (NY, WTC, WTU, WYO). Copper City, *Went 200* (UC), *Hiedeman 85* (US)*. Matanuska, *J. P. Anderson 899* (US). Skagway, *Eastwood in 1914* (CAS). YUKON. Whitehorse, *Eastwood 610, 611, 612* (CAS). Takhini River, between Whitehorse and Champagne, *Michel 46* (UC)*. MACKENZIE. Fort Good Hope, *Onion in 1861–1862* (NY)*. Bernard Harbor, *Johansen 332* (NY). BRITISH COLUMBIA. Lake Atlin, *Eastwood 680a* (CAS, US). MANITOBA. Churchill, *Macoun 79102* (GH, NY).

The epithet *varians* is most appropriate to the present variety, for it is indeed variable in stature, vesture, length of stipule-blades, length of scapes and leaves, number and disposition of the leaflets, number of flowers to the raceme, and length of calyx-teeth, evidently composed, in fact, of numerous small races. The extremes in stature and in number of leaflets are approximately as great as those found in the cordilleran vars. *gracilis* and *Cusickii* combined, but it is impossible to sort the Alaskan material into two categories on the basis of these characters. Neither is it possible to admit the existence of two species from the far Northwest marked by the presence and absence of paired leaflets in some of the leaves, maintained by Porsild, as *O. hyperborea* and *O. campestris*, and by Hultén, as *O. varians* and *O. gracilis*. The degree to which the leaflets are geminate, and the number so disposed, are inconstant in plants of the same collection, or in collections from the same locality, and are correlated neither with the shape of the stipule-blades, the color of the calyx-hairs, nor with the density of the vesture. Curious and striking though it be, the character of pseudo-verticillate leaflets is now known to occur sporadically in several species, such as *O. viscida*, *O. arctica* and *O. campestris* var. *gracilis* in America, as well as in the Kamtchatkan *O. erecta* Kom., and can no longer be given much weight when supporting characters are lacking.

The var. *varians* is very close to the European race of *O. campestris*, and Porsild's identification of the arctic American plant with relatively few, non-verticillate leaflets as the Linnaean species is hard to refute. The stipules of both bear clavate processes on the margins of the blades and no absolute quantitative difference has been found in any single organ. Prevailingly, however, the scapes and racemes of var. *varians* are more drawn out, so that the average individual resembles var. *gracilis* rather than the European type. Dwarfed forms, such as are common in many herbaceous

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[10] Asterisk indicates some geminate leaflets present.

plants in high latitudes, are of frequent occurrence, and these differ from true *O. campestris* only in the smaller flower. Obviously the relationship is a close one, but they seem not to be identical. When dwarfed the European race does not have diminished flowers, and even in its largest phase the raceme remains few-flowered and condensed in fruit. In fact as it goes north in Arctic Europe it passes into the ampler-flowered var. *sordida;* whereas the American counterpart tends to become smaller-flowered within the Arctic circle. The two react differently to similar circumstances, have different (even though somewhat overlapping) ranges of variation, and seem therefore to deserve separate treatment.

Hultén has referred all material of the *campestris* type (when lacking paired leaflets) to *O. gracilis*, and the writer has so annotated a number of herbarium sheets. The Alaskan and cordilleran plants are entirely similar, except for the presence in the former of clavate processes mixed with, or sometimes replacing, the bristly ciliae of the stipule-margins. These processes, which are deciduous from the ageing stipules, are known in several boreal species of *Oxytropis* such as *O. Maydelliana* and *O. arctica,* and although variable in quantity, seem to be a stable and characteristic attribute in the genus which can scarcely be ignored in this case, especially in view of the geographic segregation.

The flowers of var. *varians* are white or ochroleucous, drying straw-color, the keel concolorous or rarely maculate. In the type of *O. alaskana* A. Nels., which is here, as by Hultén, reduced to the common Alaskan species, the flowers appear to be yellow, as in *O. Maydelliana,* and the petals are all a little longer than usual in var. *varians.* On the supposition that this and a few similar specimens from Kenai Peninsula and the Lake Iliamna region might be derived from an *O. Maydelliana* x *campestris* var. *varians* cross, they have been mapped with the former species. It is as likely, however, that they represent a distinct variety or local population. The following collections are of the *O. alaskana* type:

Alaska. Kachemak Bay, Cook Inlet[11], *Gorman 1560* (WTU), isotype of *O. alaskana).* Halibut Cove, Cook Inlet, *Coville & Kearney 2418* (US). Seldovia, *Piper 4451* (US, WTC), *4445* (WTC). Lake Iliamna district, *Gorman 187* (CAS).

15b. **Oxytropis campestris** (L.) DC. var. **gracilis** (A. Nels.) Barneby

Oxytropis campestris (L.) DC. var. *gracilis* (A. Nels.) Barneby, Leafl. West. Bot., 5:111. 1951. *Aragallus gracilis* A. Nels., Erythea, 7:60. 1899 *Oxytropis gracilis* (A. Nels.) K. Schum., Just's Jahresb., 27^1:496. 1901.

Oxytropis Lambertii β Hook., Fl. Bor.-Amer., 1:107. 1834.

Oxytropis monticola Gray, Proc. Amer. Acad., 20:6. 1884, pro max. parte. *Spiesia monticola* (Gray) O. Kze., Rev. Gen., 206. 1891. *Aragallus monticola* (Gray)

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[11] Not, as claimed by Hultén, Fl. Alaska & Yukon 1098, from "Red Mountain (near Fort Selkirk)."

Greene, Pittonia, 3:212. 1897. *Astragalus Grayanus* Tidestr., in Tidestr. & Kitt., Fl. Ariz. & New Mex., 216. 1941, quoad nom. (non *A. monticola* Phil.).

Aragallus villosus Rydb., Bull. Torr. Club, 28:36. 1901. *Oxytropis villosa* (Rydb.) K. Schum., Just's Jahresb., 29¹:543. 1903. *Astragalus Rydbergianus* Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937 (non. *A. villosus* Mchx.).

Aragallus luteolus Greene, Proc. Biol. Soc. Wash., 18:17. 1905. *Oxytropis luteola* (Greene) Piper & Beattie, Fl. N.-W. Coast, 337. 1915; A. Nels., Univ. Wyo. Pub. Bot., 1:117. 1926 (as "comb. nov.").

Aragallus albertinus Greene, Proc. Biol. Soc. Wash., 18:15. 1905. *Oxytropis albertina* (Greene) Rydb., Fl. Prair. & Pl., 484. 1932. *Astragalus albertinus* (Greene) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937.

Aragallus cervinus Greene, Proc. Biol. Soc. Wash., 18:16. 1905.

Aragallus Macounii Greene, l. c., pro parte.

Oxytropis olympica St. John, Proc. Biol. Soc. Wash., 41:103. 1928.

Oxytropis Mazama St. John, op. cit., 101. 1928. *Astragalus Mazama* (St. John) G. N. Jones, Univ. Wash. Pub. Bot., 7:175. 1938.

Oxytropis okanoganea St. John, op. cit., 102. 1928.

Oxytropis cascadensis St. John, op. cit., 105. 1928.

Densely cespitose, or sometimes with openly branched caudex; herbage green and sparingly or finely pilose, sometimes permanently and densely silky-pilose, the scapes commonly bearing some divergent hairs at base, rarely villous-hirsute throughout; stipules almost glabrous to densely pilose dorsally, the free blades 3–15 mm. long, ciliate or eciliate; leaves somewhat dimorphic, 6–23 cm. long, the developed secondary ones with (13) 17–33 linear-oblong, lanceolate, or obovate leaflets 6–23 (30) mm. long, all commonly opposite or subopposite, or a few inserted in unequal pairs at the same point on the rachis; scapes erect, (7) 10–30 cm. long; racemes 10–30-flowered, usually dense at first and at full anthesis, much or but little elongating in fruit, when narrow and 2–11 cm. long; bracts pilose dorsally, sometimes sparingly so, shorter than to nearly twice as long as the calyx; calyx pilose or hirsutulous, often with some fuscous hairs, 7–9.5 mm. long, the tube 4.5–6.5 mm., the teeth 1.5–2.5 (3) mm. long; corolla whitish or ochroleucous; banner 12–17 (19.5) mm. long, 4–7 (9) mm. wide, wings 10–16 mm. long, the blades oblong, 2.5–4 mm. wide near the truncate or emarginate apex, rarely dilated upward and up to 5.5 mm. wide; keel 10–14.5 mm. long. *Type* collected by Aven Nelson, in 1896, in the Limestone Range of the Black Hills, Wyoming; Limestone Range, Weston County, Wyoming, *A. Nelson 2545* (GH, NY, US, isotypes)!

Distribution: Prairies, mountain meadows or open woodland, in moist or dry soils, from s.-w. Manitoba to British Columbia, and in the Rocky Mountains from Alberta to Colorado and the Black Hills of South Dakota; also in the northern Cascade and Olympic ranges of Washington. Map 8.

Representative specimens: Without locality, Franklin Expedition (GH, as *O. Lambertii β*, and as *O. Lambertii*, both ex herb. Hooker., presumably collected by Richardson in Canada). BRITISH COLUMBIA. Similkameen River, *Macoun 70410* (GH, ND, NY). Deer Park, Lower Arrow Lake, *Macoun 5358* (ND, type of *Aragallus cervinus).* ALBERTA. Elbow River, *Macoun 18517* (ND, cotype of *Aragallus Macounii).* Mistaya River, near Mt. Murchison, *Hitchcock & Martin 7782* (NY, POM, WTC, WTU)*[12]. Upper Waterfowl Lake, Banff-Jasper Hwy., *A. & R. Nelson 3100* (GH, NY, WTU). SASKATCHEWAN. Without locality, *Bourgeau in 1858* (GH, NY). 25 mi. w. of Touchwood, *Macoun & Herriott 70792* (G, ND, NY). Prince Albert, *Macoun 12535, 12540* (ND, cotypes of *Aragallus albertinus).* MANITOBA. Mouth of Qu'Appelle River, *Macoun & Herriott 70795* (CAS, ND, NY). WASHINGTON. Olympic Mts., Clallam County, *A. D. Elmer 2532* (US, type of *Aragallus luteolus,* ND, NY, MINN, WTC). Olympic Mts., Jefferson County, *Flett 134* (WTC, type of *O. olympica).* Marmot Pass, Jefferson County, *J. W. Thompson 9932* (CAS, NY, POM, WTC, WTU). N.-w. of Riverside, Okanogan County, *St. John 7728* (WTC, type of *O. okanoganea).* Goat Mts., Pierce County, *O. D. Allen 245* (WTC, type of *O. Mazama,* CAS, NY, RB, WTU). Mt. Wow, Pierce County, *J. W. Thompson 12578* (CAS, NY, POM, WTC, WTU). Grouse Creek, Mt. Baker, Whatcom County, *St. John 5513* (WTC, type of *O. cascadensis).* MONTANA. Jocko River, Lake County, *Canby 91* (GH, lectotype of *O. monticola).* Craig, Lewis and Clark County, *Wilcox 378* (US, type of *Aragallus villosus,* NY)*. Cut Bank Creek, Glacier County, *G. N. Jones 5491* (GH, NY). Westby, Sheridan County, *Esther Larsen 10* (GH). WYOMING. Laramie Peak, Albany County, *A. Nelson 7523* (GH, NY, POM). SOUTH DAKOTA. Custer, Custer County, *Rydberg 636* (GH, NY), COLORADO. Nelson, Jackson County, *Ripley & Barneby 9010* (CAS). Phantom Valley Ranch to Idaho Springs, Clear Creek County, *Mrs. Cantelow in 1942* (CAS).

The present variety is the plant currently passing in the literature as *O. gracilis* and, in small and varying degrees of correctness, as *O. monticola,* the small-flowered *Oxytropis* with numerous leaflets and whitish flowers common at middle altitudes in the northern Rocky Mountains, in the northern Cascades (where often called *O. luteola),* and on the plains of the Saskatchewan. It is variable especially in the amount and orientation of the pubescence, to some extent in the size of the flowers, and in other characters. When growing in deciduous woodland, open pine-forest, or in moist mountain parks, the plants are inclined to be sparingly pilose, with thin, green leaflets, and the stipules tend to be dorsally glabrous and sparsely, if at all, bristly-ciliate along the edges of the free blades. The plant of drier or more exposed sites is commonly silky-pilose, with smaller and thicker leaflets, and the stipules are at first, or permanently, pilose dorsally and ciliate. Passage between the silky and glabrescent states is established by many intermediate forms, and both may occur together (cf. *Johnson*

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[12] Asterisk indicates some geminate leaflets present.

158, from the Black Hills, NY), or in the same immediate region. Rydberg maintained the green state as *O. glabrata* (erroneously based on *O. campestris* var. *glabrata,* the type of which is apparently *O. Maydelliana),* an arbitrary segregate based on a single unstable character. Whatever the density of the vesture, the scapes may be appressed-pilose or bear some long and loosely ascending to divaricate hairs near the base and below the inflorescence, as in the isotypes of *O. gracilis,* or may even become copiously villous their whole length, as in the type of *Aragallus villosus.* The primary and secondary leaves are usually dissimilar in the size and shape of the leaflets, dimorphism being accentuated in the more xerophytic state. The leaflets are normally opposite or scattered, but paired and pseudo-verticillate leaflets are not uncommon. In some cases a single leaf may bear two leaflets attached at a point, while in others paired leaflets are numerous in some or nearly all the secondary leaves, a tendency especially marked in plants from the foothills of Alberta Rockies.

On the Northwest coast and in the Cascade Range the situation in var. *gracilis* becomes quite complicated. *Oxytropis luteola, O. olympica, O. cascadensis,* and *O. Mazama,* all of northern Washington, are not exactly alike. St. John separated *O. luteola* and *O. olympica* on the basis of differences in size of corolla and leaflets, and on the degree of pubescence in the stipules, but these characters are interchangeable in material from the Oympic Mountains, where both species are said to be endemic, and, as pointed out by G. N. Jones (Univ. Wash. Pub. Bot., 5 : 189), the vesture of a stipule depends to some extent on its position in the year's cycle of growth, the inner or later ones which subtend the secondary leaves being commonly less hairy than those of the exterior primaries. Jones nevertheless maintained *O. olympica* on its supposedly narrower leaflets, smaller flowers, and denser, fewer-flowered racemes. Here again the characters stressed are by no means always coincident, and Jones's concept of both species is weakened by the fact that he cited as representative of each some specimens of the Olympic phase of *O. viscida.* The *Oxytropis* of the Olympics exhibits great variation in flower-size, but no greater than does var. *gracilis* in the type-region of the Black Hills, and the conclusion of Abrams (Ill. Fl. Pac. St., 2:611, fig. 2917, 1944) that there is but one species of *Oxytropis* in that range is accepted. *Oxytropis Mazama,* except for St. John's record from the Olympics endemic to Mt. Rainier, and *O. cascadensis* from Mt. Baker are almost exactly similar. The former was said to differ from the rest in its dorsally glabrous stipules, but a few scattered trichomes are to be seen in an isotype (WTU). St. John claimed that *O. cascadensis* could be distinguished from *O. luteola* and *O. olympica* by its smaller calyx (7–8 mm. long at anthesis) and fewer (18–21) leaflets. But in part of *Flett 803* (WTU), a plant from the Olympics referred to *O. olympica* by St. John himself, the fruiting calyx is only 6.5 mm. long; and the leaflets in plants from Mt. Baker may number 28 to the leaf. In general it can be said that the Cascadean populations are less densely pilose than those of the Olympics, and that they perhaps too closely approach in stature and leaflet-number the var. *Cusickii.* What was later to be taken as the type of *Aragallus luteolus* was early identified by Piper (Fl. Wash., 367) as *O. gracilis,* and those of *O. olympica* and *O. Mazama* as *O. monticola,* but he offered no contrasting characters between the species; in fact there seem to be none of significance.

The northwestern segregates so far noted are all montane plants of medium stature. In northern Washington and adjacent British Columbia, particularly along the Okanogan River, there occurs a robust lowland ally of *O. campestris,* described independently as *Aragallus cervinus* Greene and as *O. okanoganea* St. John, the last distinguished from its close relatives by densely pilose stipules and large leaflets. In the extreme state, with tall erect, often villous scapes, ample herbage and lax racemes of large flowers, this appears adequately distinct. However the peculiar habit may be combined with glabrescent stipules (cf. *Elmer 595,* from Mt. Chacpaca, NY), while we have from British Columbia a suite of forms in which densely pilose stipules are combined with gradually diminished stature (cf. *J. W. Thompson 45*, from Kamloops, CAS, NY, WTU) until at the end of the series one arrives back at a plant inseparable from the montane races of var. *gracilis.* Perhaps more striking than the characters of vesture and stature in *A. cervinus* is the frequent reduction in leaflet-number, a densely silky plant such as *Macoun 70411* (from Mt. Osoyoos, NY) having some mature leaves with no more than 13–15 leaflets, although others similar in facies (cf. *J. W. Thompson 36*, from Spence's Bridge, NY, WTU) bear up to 21 leaflets. Meanwhile in extreme northwestern Montana (cf. *Kirkwood 1190,* NY) the reduction of leaflets is combined with the large flower of *A. cervinus* and nearly glabrous stipules and herbage, a state uncomfortably reminiscent of the otherwise subalpine and small-flowered var. *Cusickii.* Toward the culmination of its line of development *A. cervinus* does assume an aspect not duplicated elsewhere in the range of var. *gracilis,* but the material intergradient in one way or another is so much more copious than that identifiable as the extreme form, that a definition of it seems impracticable at present. Both Rydberg and Dayton have reduced *A. cervinus* to *O. sericea* var. *spicata* (as *A. spicatus* and *O. Macounii* respectively), no doubt on account of its ample flowers with broad wings; but the type unquestionably belongs with the thin-podded, *O. campestris* series.

The var. *gracilis* has been known for well over a century, and has had a chequered nomenclatural history. The *O. campestris* of early authors was no doubt partly this variety, though it is now scarcely possible to unravel the fluctuating concepts of the species in American literature. It was first brought into the open and extricated from European *O. campestris* and from *O. Lambertii* in Gray's second revision (1884), where it received the name *O. monticola.* This species was based on six collections, not quite all conspecific, cited as follows: "Northern Rocky Mountains, viz., Wyoming and Montana, *Parry,* no. 87, *Canby;* Dakota, coll. *Jenney,* but in flower only. Rocky Mountains in British Possessions, *Bourgeau,* with fruit, *Lyall,* in flower only; and Spy Hill, *Macoun,* 1879, no. 107, in fruit." The plants of Canby, Bourgeau, Lyall and Macoun (all GH) are ochroleucous-flowered var. *gracilis;* the Jenney collection belongs to var. *dispar;* while *Parry 87* represents a rare state of *O. viscida* in which the bracts are dorsally pilose. The last has been annotated by C. L. Porter (GH) as type of *O. monticola,* doubtless because it was the first cited, and if this choice is accepted the name must fall into the synonymy of *O. viscida.* Gray, however, pointedly set off his new species from *O. viscida* and *O. leucantha,* defined as "pl. m. viscosa, saltem calyces," by the phrase "nec glandulosa nec viscida" and further emphasized the point that *O. monticola* was "like *O. viscida* Nutt., but neither glandular nor viscid." To proclaim typical of a species a specimen which so exactly contradicts the diagnosis and description is a fundamental misuse of the type-principle. The fact that Gray overlooked the glandular warts on the bracts, calyx, and legume of *Parry 87,* and cited it as belonging to *O. monticola,* cannot outweigh his repeated stress on the absence of viscidity. There can be no question as to what Gray had in mind as *O. monticola,* and the name, based if one must choose on *Canby 91* (GH, lectotype!), has obvious priority, in the specific category, over *O. gracilis.* But in order to avoid the possibility of confusion it has seemed best to take up, in the varietal rank, the later epithet *gracilis,* as to whose application no doubt is likely to arise.

Partly owing to the mixed nature of Gray's material, *O. monticola* has been widely misunderstood. Rydberg early recognized the identity of *Parry 87,* and cited *O. monticola* (Cont. U. S. Nat. Herb., 3:493) in the synonymy of *Spiesia viscida.* At various times Nelson applied the name to specimens of *O. Lagopus* var. *atropurpurea, O. Besseyi* var. *Besseyi,* and *O. Besseyi* var. *ventosa.* In the Flora of Montana Rydberg transferred the name to white-flowered *O. campestris* var. *Cusickii* and later (Fl. Rocky Mts.), in the key defined *O. monticola* as an eglandular plant with small purple flowers, supposedly confined to Wyoming and Colorado. Nothing is known from this area which agrees with Rydberg's concept at this date and, significantly, there is not one sheet at New York Botanical Garden labelled *O. monticola* in Rydberg's hand; clearly *O. monticola* of this reference was a chimera, compounded of the small purple flower of Parry's plant and the eglandular herbage described by Gray. In his most recent paper on *Oxytropis* (Univ. Wyo. Pub. Bot., 1: 109–121, 1926) Nelson made no mention of *O. monticola* either among the "common Locos" or the "troublesome and doubtful species," even though it should have been by original definition a plant of the range under consideration and one of the earliest names applied to a western species. Lately Tidestrom has substituted for *O. monticola* the name *Astragalus Grayanus* and (loc. cit.) there conceives the species as purple-flowered, with "leaflets 7–11," ranging southward to so remote and improbable a region as Flagstaff, Arizona[13]; in its many vicissitudes *O. monticola* was never so carelessly interpreted.

Spontaneous hybrids involving var. *gracilis* are discussed under the headings of *O. viscida* and *O. sericea.*

15c. **Oxytropis campestris** (L.) DC. var. **Cusickii** (Greenm.) Barneby

Oxytropis campestris (L.) DC. var. *Cusickii* (Greenm.) Barneby, Leafl. West Bot., 5:111. 1951 (Jan.); R. J. Davis, Madroño, 11:144. 1951 (Jul.). *O. Cusickii* Greenm., Erythea, 7:116. 1899.

Aragallus alpicola Rydb., Mem. N. Y. Bot. Gard., 1:252. 1900. *Oxytropis alpicola* (Rydb.) Jones, Mont. Bot. Notes, 37. 1910; non Turcz. (1842). *O. Rydbergii* A. Nels., Univ. Wyo. Pub. Bot., 1:117. 1926. *Astragalus alpicola* (Rydb.) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937. *Oxytropis campestris var. Rydbergii* (A. Nels.) R. J. Davis, Madroño, 11:144. 1951.

Oxytropis Paysoniana A. Nels., Univ. Wyo. Pub. Bot., 1:119. 1926.

Similar to var. *gracilis* but usually lower, densely or thinly pilose throughout; stipules glabrous or sparingly pilose toward the base, the free blades ciliate or eciliate; leaves 1.5–12 cm. long, erect or spreading, with 7–15 (17) leaflets 3–15 (23) mm. long; scapes erect, arcuate-ascending or prostrate, 2.5–15 cm. long, glabrate, appressed-pilose or rarely villous-pilose toward the base or even throughout; racemes 3–15-flowered, little elongating, the axis 0.5–3 (6) cm. long in fruit; bracts pilose dorsally or at length glabrescent; calyx 7–9 (10) mm. long, the tube fuscous-strigose or variously pilose-hirsute with longer and looser pale or dark hairs, the teeth (1.5) 2–3 mm. long; petals ochroluecous, concolorous, or the keel perhaps sometimes maculate; banner 14–18 (20) mm. long; keel 11–12.5 mm. long. *Types* collected by W. C. Cusick, in "1891" (or 1886 according to the label) and 1898, on alpine summits of the Wallowa Mountains, eastern Oregon; Wallowa Mts., *Cusick 1365* (GH), *2095* (GH, ND, UC, US)!

Distribution: Rock-slides, stony ridges and alpine or subalpine meadows, chiefly above timberline, between 7,000 and 11,000 ft. altitude, from northern Colorado northward on and near the Continental Divide to Alberta and British Columbia, westward to Idaho, the Wallowa Mts., Oregon, and the Wenatchee Mts. and Okanogan County, Washington. Map 8.

Representative specimens: BRITISH COLUMBIA. Carbonate Draw, *C.H. Shaw 345* (NY, US). ALBERTA. Mt. Paget, Rocky Mt. Park, *Macoun 65075* (GH, NY). Upper Carthew Lake, *Hitchcock & Martin 7910* (POM, WTU).

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[13] The only oxytropis known definitely from Flagstaff is *O. Lambertii* var. *Bigelovii,* but Tidestrom's description suggests the more robust phase of *O. oreophila,* which seems to find its southern limit on the Kaibab north of Grand Canyon.

Washington. Table Mt., Kittitas County, *J. W. Thompson 9806* (CAS, NY, POM, WTU). Rocky Mt., trail to Tiffany Lake Pass, *Fiker 379* (WTC). Oregon. Lostine Canyon, Wallowa County, *Peck 17880* (NY, WTU). Idaho. Mackay, Custer County, *Nelson & Macbride 1464* (NY, POM). Montana. East Pintlar Peak, Anaconda Range, Beaverhead County, *Hitchcock & Muhlick 12861* (CAS, WTC). Sexton Glacier, Glacier Nat. Park, *Standley 17271* (US). Old Hollowtop near Pony, *Rydberg & Bessey 2503* (NY, type of *Aragallus alpicola,* GH, ND). Wyoming. Big Horn Mts., Sheridan County, *Tweedy 2376* (NY). Summit of Piney Mt., Sublette County, *E. & L. Payson 2700* (NY, US, isotypes of *O. Paysoniana).* Powder River Pass, Washakie County, *M. Ownbey 813* (IDS, WTC). Utah. Goodman's Ranch, Bear River, Summit County, *E. & L. Payson 4868* (POM). Colorado. Breckenridge, Summit County, *K. K. Mackenzie 118* (NY).

The var. *Cusickii* is intimately related to var. *gracilis,* differing principally in the relatively few leaflets to the developed leaves. The two are nearly identical in corolla and pod, varying in the size of these organs, as well as in the density of vesture, to about the same degree. The scapes may be strictly erect, arcuate-ascending, or in exposed sites prostrate, the last state corresponding with *Aragallus alpicola.* During the preliminary studies, an attempt was made to maintain the latter as a distinct variety of *O. campestris,* and a number of herbarium sheets were so labelled. The condensed and depressed alpine state appears to have a more northern range, from western Montana northward, but the more rigorous conditions could as well account for the difference in stature, low scapes, and few-flowered racemes, and there are no supporting characters. The keel of *A. alpicola* was originally described as ''tipped with purple,'' but no trace of color remains on the type, and the flowers of all the material seen by the writer appear to have been concolorous when fresh. Rydberg, however, saw the fresh flower, so the purple spot may occur, though it is certainly fugacious.

Oxytropis Cusickii and *O. Paysoniana* are unquestionably conspecific. In the type-collections of each the calyx may be strigose with dark hairs and pale-hirsutulous as well, or the longer looser hairs may be altogether deficient. Nelson made no remark of a diagnostic nature when describing *O. Paysoniana,* merely stating that the specimens before him had been distributed as *O. alpicola* and *A. luteolus;* probably he did not know authentic *O. Cusickii,* at least at that time.

Up to the present *O. Cusickii* (often erroneously attributed to E. L. Greene) has been thought to be confined to the Wallowa Mountains. Blankinship, it is true, recorded (Mont. Agric. Sci. Stud., 1:80, 1905) a collection from Montana, but it was not admitted by Rydberg to the Rocky Mountain Flora (1917). Recently Abrams has referred to it some plants of the Cascade Range in northern Washington, but these seem to be nearer to var. *gracilis.* As here defined, var. *Cusickii* replaces var. *gracilis* in the mountains of Idaho, western Wyoming, and Montana, north of which it is separated from var. *gracilis* by altitude and life-zone. At the latitude of Banff var. *gracilis,* which is montane or submontane southward, is down in the valleys, while var. *Cusickii* occupies the summit screes.

15d. **Oxytropis campestris** (L.) DC. var. **dispar** (A. Nels.) Barneby

Oxytropis campestris (L.) DC. var. *dispar* (A. Nels.) Barneby, Leafl. West. Bot., 5:111. 1951. *Aragallus dispar* A. Nels., Erythea, 7:61. 1899, sensu stricto. *Oxytropis dispar* (A. Nels.) K. Schum., Just's Jahresb., 27^1:496. 1901; Cockerell, Torreya, 18:180. 1918 (as "comb. nov.").

Densely and permanently silky-pilose, the stipules usually concealed by the vesture; leaves strongly dimorphic, the primaries short, with short, crowded ovate leaflets, the upper with 19–25 linear-lanceolate or narrowly oblong leaflets up to 2 cm. long; scapes 7–19 cm. long; racemes 8–15-flowered, the axis becoming 3–8 cm. long in fruit; calyx 8–9 mm. long, the tube 6–6.5 mm., the teeth 2–2.5 mm. long; petals purple, blue, pink, white, or ochroleucous, the banner 17–19 mm. long, 6–8 mm. wide; wings 14–16 mm. long, the blades dilated upward and 4.5–6 mm. wide near apex; keel 12–13 mm. long; pod of firmer texture than in related forms. *Type* collected by Mrs. C. R. Cook, in 1896, at Dickinson, North Dakota; Dickinson, Stark County, *Mrs. Cook* (WYO)!

Distribution: Prairies or brushy places along ravines, apparently confined to North Dakota. Map 8.

Specimens examined: "Dakota," *Jenney* (GH). Bismark, Burleigh County, *Sadie Lauterman in 1891* (OB). Butte, Benson County, *Lunell in 1904, 1905, 1906, 1907 and 1908* (all NY). Sentinel Butte, Golden Valley County, *Hanson in 1936* (UC). Kulm, Lamoure County, *Brenkle in 1906* (NY). Washburn, McLean County, *Bergman 1601* (OB). Ward County, *Lunell in 1909* (NY). Williston, Williams County, *O. A. Stevens in 1918* (NY).

This odd prairie race is closely related to var. *gracilis,* from which it is distinguished only by the polychrome coloration of the flowers and by the somewhat firmer texture of the pod. The dimorphism of the leaves, to which the epithet *dispar* refers, has been overstressed, for it appears occasionally in equally extreme form in undoubted races of var. *gracilis.* It may well be that var. *dispar* originated as a fertile hybrid between white-flowered var. *gracilis* and purple-flowered *O. Lambertii,* common in the same region. Lunell's suite of specimens from Butte is suggestive here, for the collector noted (NY): ". . . this plant has about 15 different shades of the flowers, from white, cream-color, light blue, dark blue and dark purple; these colors mixed present the most gorgeous aspect . . ." Similar polychrome populations, believed to be derived from crossing of *O. sericea* and *O. Lambertii,* are noted elsewhere in this paper. Morphologically var. *dispar* is somewhat intermediate, resembling var. *gracilis* in number and disposition of the leaflets and in the basifixed pubescence, while the more nearly coriaceous pod and broad wing-petals could have been inherited from *O. Lambertii.* Other suspected hybrids in the genus occur only where the parents grow in immediate association. Here the situation is different, for only one parent, *O. Lambertii,* is present. However, var. *gracilis,* although chiefly montane in the latitude of North Dakota, does come out onto the plains of northeastern Montana, the station at Westby, Sheridan County, being closely adjacent to the westernmost locality of var. *dispar* in Williams County, N. D. Whatever its history, var. *dispar* seems to be self-perpetuating at the present time. During the preliminary studies, most of the material seen in herbaria was annotated as var. *gracilis,* of which it was thought to be a minor variant, but as additional collections have come to light and its natural area has become better defined, it seems proper to maintain it as a named entity.

The name *dispar* has been generally applied, by Nelson himself and by Rydberg, to a form of *O. Lambertii* with dimorphic leaves, further discussed under the head of that species. However, in the type of var. *dispar,* which consists of two roots, one bearing ochroleucous, the other purple flowers (thus confirming its identity), the pubescence is entirely basifixed.

15e. **Oxytropis campestris** (L.) DC. var. **columbiana** (St. John) Barneby

Oxytropis campestris (L.) DC. var. *columbiana* (St. John) Barneby, Leafl. West Bot., 5:111. 1951. *O. columbiana* St. John, Proc. Biol. Soc. Wash., 41:100. 1928.

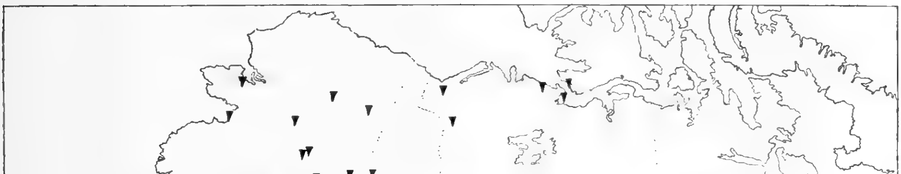
Robust, tufted on a heavy taproot, the herbage silky-pilose, greenish or canescent; stipules prevailingly pilose dorsally, rarely glabrescent, the deltoid to caudate-acuminate free blades 6–13 mm. long; leaves (5) 8–17 cm. long, with 11–17 broadly lance-oblong to narrowly elliptic leaflets 9–30 mm. long; scapes erect, (1) 2–3 dm. long, commonly bearing some spreading hairs at base; racemes (6) 10–28-flowered, at first dense and oblong, the axis becoming 2–10 cm. long in fruit; calyx loosely silky-pilose, often with many dark hairs, 7.5–10 mm. long, the tube 5–6.5 mm., the teeth (2) 2.5–4 mm. long; corolla white, the banner veined and the keel maculate with purplish-blue; banner oblanceolate-obovate, 15.5–20 mm. long, about 6 mm. wide; wings 13–18 mm. long, the obliquely oblong blades 9–11.5 mm. long, 3–4 mm. wide; keel 12–17 mm. long. *Type* collected by Harold St. John, in 1924, on the gravelly beach of the Columbia River near Marcus, Stevens County, Washington; *St. John 6482* (WTC, GH)!

Distribution: Gravel-bars and stony river- or lake-shores, between 1,200 and 3,000 ft. altitude, along the Columbia above the mouth of the Spokane in northeastern Washington, and about Flathead Lake in northwestern Montana. Map 8.

Representative specimens: WASHINGTON. Inchelium, Ferry County, *Rogers 529* (CAS, NY, POM, WTC, WTU). Below Gifford, Stevens County, *Rogers 520* (CAS, NY, POM, IDS, WTC). MONTANA. White Swan Bay, Flathead Lake, *Reed & Barkley 19* (NY, US, WTC).

The var. *columbiana* differs absolutely from var. *gracilis* only in the color of the flowers, in other respects closely simulating the robust, lowland form of the latter which has been described as *Aragallus cervinus* (cf. discussion of var. *gracilis).* There is a tendency for the calyx-teeth to be longer, but complete intergradation is found in this direction. From var. *Cusickii,* with which it has relatively few (11–17) leaflets in common, it differs in its greater stature, more numerous flowers, purple keel, and riparian habitat. In essential characters of flower, fruit, and habit the variety is so nearly identical with other races of *O. campestris* that it can scarcely be considered as more than a minor derivative of the complex.

The direction and extent of variability in var. *columbiana* is significant in evaluating criteria used in the species as a whole. Assuming that the



Map 8. Range of *Oxytropis campestris* in America: var. *varians* ▼; var. *gracilis* ●; var. *gracilis*, the "*cervinus*" form △; var. *Cusickii* ▲; var. *dispar* ■; var. *columbiana* X; var. *terrae-novae* ▶; var. *johannensis* +; var. *chartacea* ✱.

seven flowering collections known from the banks of the Columbia in Ferry and Stevens counties, all with white banner and maculate keel, are conspecific in the narrowest sense, the race so represented varies to a surprising degree in density of vesture, size of flower, and other characters. The stipules are most commonly pilose throughout, but the free blades may become glabrate, or the whole dorsal face (cf. *Rogers 414,* from Northport, NY) glabrous except for a few scattered hairs along the midrib. The scapes, prevailingly ascending-pilose or even hirsute at base, may be appressed-pilose throughout, and the banner varies from 15.5 to 20 mm. in length, the keel from 12 to 17 mm. Once such latitude has been admitted to a race of limited distribution and somewhat specialized habitat, it becomes easy to appreciate the slight value of these same criteria in *O. campestris* as a whole.

15f. **Oxytropis campestris** (L.) DC. var. **terrae-novae** (Fern.) Barneby

Oxytropis campestris (L.) DC. var. *terrae-novae* (Fern.), comb. nov. *O. terrae-novae* Fern., Rhodora, 30:147, Pl. 174. 1928.

Oxytropis uralensis γ *minor* Hook., Fl. Bor.-Amer., 1:146. 1834, pro parte, quoad pl. labrador.

Low, loosely cespitose, the slender divisions of the caudex sometimes elongating and up to 5 cm. long, the herbage green, sparingly pilose with appressed and a few ascending hairs, exceptionally silky-pilose to maturity; stipules glabrous or nearly so dorsally, the free blades deltoid to lance-acuminate, 2–7 mm. long, eciliate or sparsely bristly at apex; leaves (2) 3–10 (13) cm. long, with 11–23 (27) distant, lanceolate to elliptic, rarely ovate, acute or acutish leaflets 2–10 mm. long; scapes arcuate-ascending 3–12 (16) cm. long; racemes (3) 5–9-flowered, subcapitate, the axis 3–15 mm. long in fruit; bracts sparingly pilose to quite glabrous dorsally; calyx pilose with fuscous and some longer pale hairs, 5–7 mm. long, the tube 4.5–6 mm., the teeth 0.5–1.5 mm. long; petals purple, drying violet; banner 11–18 mm. long, 4.5–6 mm. wide; wings 10–15 mm. long, the oblong-obovate blades not much dilated upward, 3–4.5 mm. wide near the obliquely truncate-emarginate apex; keel 9–13 mm. long, the appendage 1 mm. long or reduced to a minute boss. *Type* collected by M. L. Fernald and colleagues, in 1925, on St. John Island, Newfoundland; *Fernald et al. 28615* (GH)!

Distribution: Turfy or peaty barrens near the coast, Ungava Peninsula, Labrador, and west coast of Newfoundland, south to about latitude 48° N.; reported from the Mackenzie Mts., N. W. T. Map 8.

Representative specimens: QUEBEC. Port Harrison, e. coast of Hudson Bay, *Malte 127018* (NY). Wakeham Bay, Hudson Strait, *Malte 126950* (NY). LABRADOR. Rama, *Stecker 364* (NY, US). NEWFOUNDLAND. Table Mt., Port-au-Port Bay, *Fernald & Wiegand 3635* (GH, NY).

Especially in general habit, var. *terrae-novae* closely resembles European

O. campestris, and, as brought out by Fernald, the bright purple flower and shorter calyx with (nearly always) shorter teeth, seem the most significant differences. Quite recently Porsild (Sargentia, 4: 52) has reported from Komaktorvik Fjord, Labrador, a specimen of supposedly authentic *O. campestris;* this record seems rather unlikely and should be rechecked.

It is interesting that var. *terrae-novae,* which passed until 1928 as *O. uralensis, O. campestris,* or some variety of one or the other, was probably the first member of the genus to be found in the New World. As early as 1800 we find mention in Pallas of a plant from Labrador, communicated by Schreber, which almost certainly must belong here (cf. *Astragalus* sp., in Pall., Astrag., 64, in nota sub *A. baicalensi),* as also the Labrador collection cited by Hooker (l. c.) as *O. uralensis* var. *minor,* and by Schlechtendal (Linnaea, 10: 99, 1835) as *O. uralensis β.*

In the absence of corresponding material it has not been possible to verify the most interesting report (Porsild, Nat. Mus. Canad. Bull., 101: 24, 1945; Raup, Sargentia, 6: 208, 1947) of var. *terrae-novae* from the east slope of the Mackenzie-Yukon divide in the Northwest Territories, where it is said to be fairly common on "limestone barrens," a habitat similar to that often favored by the variety on the west coast of Newfoundland. The occurrence of var. *terrae-novae* in the Northwest brings up the possibility that *O. uralensis* var. *minor* Hook., described from "dry hills and prairies in the Rocky Mountains" (with an additional report from Labrador) may be the earliest name for the variety. See further, under Excluded Species, below.

15g. **Oxytropis campestris** (L.) DC. var. **johannensis** Fern.

Oxytropis campestris (L.) DC. var. *johannensis* Fern., Rhodora, 1:88. 1899. *Aragallus campestris* var. *johannensis* "Fern." ex Macoun, Ottawa Nat., 13:163. 1899, nomen. *A. johannensis* (Fern.) A Hell., Cat. N. Amer. Pl., Ed. 2:7. 1900. *Oxytropis johannensis* (Fern.) Fern., Rhodora, 30:145, Pl. 173. 1928.

Oxytropis Lambertii δ ? T. & G., Fl. N. Amer., 1:338. 1938.

Oxytropis campestris var. *americana* Brunet, "Cat. Pl. Canad., 39. 1865," nom. nud., fide Fern., 1928, l. c.

Oxytropis johannensis fma. *bicensis* Vict. & Rouss., Cont. Inst. Bot. Univ. Montréal, 36:32. 1940.

Permanently silky-pilose with subappressed hairs or more often becoming green and glabrate; stipules 1–3 cm. long, glabrous to sparingly pilose dorsally, the free blades ovate-acuminate to lance-caudate, (3) 5–12 (18) mm. long; scapes erect or rarely ascending, (4) 8–36 cm. long, appressed-pilose or glabrate; racemes 7–12 (14)-flowered, oblong or clavate in early anthesis, the axis elongating and 1.5–9 (11) cm. (averaging 4 cm.) long in fruit; calyx silky-pilose with pale, often mixed with short fuscous hairs, (6) 6.5–8 mm. long, the tube 5–6 mm., the lanceolate to narrowly deltoid teeth (1) 1.5–3 mm. long; petals, except in occasional albinos, purple; banner 12–18.5 mm. long, 6–8.5 mm. wide; wings 13–15 mm. long, the blades 8–11 mm. long, slightly dilated upward and 3.5–5.5 mm. wide near the shallowly emarginate apex; keel 10–13 mm. long, the usually straight appendage less than 1 mm. long. *Type* collected by M. L. Fernald, in 1898, on beaches of St. John River, Fort Kent, Aroostook County, Maine; *Fernald 2289* (GH, US)!

Distribution: Rock-ledges, islands, and gravel-bars along rivers of northern Maine, New Brunswick, and Gaspé Peninsula; along the south shore of St. Lawrence River up to Ile d'Orleans; and on cliffs, headlands, and coastal barrens from St. Paul Island, Nova Scotia, to the southwest coast of Newfoundland. Map 8.

Representative specimens: NEWFOUNDLAND. Ha-ha Point, Ha-ha Bay, *Fernald & Long 28603* (GH, NY). NOVA SCOTIA. St. Paul I., *Perry & Roscoe 266* (NY, US). QUEBEC. Ile Bonaventure, *Marie-Victorin & al. 17251* (GH, NY). Near Quebec, *Mrs. Percival* (NY, the *O. Lambertii* δ? of T. & G.). Mont Bic, Rimouski County, *Rousseau 31031* (US). Restigouche River, below Patapédia, *Rousseau & Bonin 32238* (OB). NEW BRUNSWICK. St. John River, e. of Clair, *Fernald & Pease 25168* (GH, NY). MAINE. Fort Kent, Aroostook County, *K. K. Mackenzie 3406* (NY), *3415* (NY, flowers white).

Oxytropis johannensis falls well within the extended concept of *O. campestris* adopted in this paper, being structurally indistinguishable in flower, stipule, and legume from other races of the species, and it is therefore possible to take up the trinomial under which it was originally described, and which admirably expresses its affinities. The exactly typical form, from watercourses in the interior, is a coarse plant with elongate scapes and ample foliage but examples from the coast are more condensed, and a collection from Cow Head, Newfoundland (*Fernald & Wiegand 2633,* GH, NY), includes an individual as dwarf in stature as the prevailing state of var. *terrae-novae.* Similarly a specimen from Cape St. George, Newfoundland (*Mackenzie & Griscom 11054,* NY), with the technical characters of var. *terrae-novae,* is densely silky-pilose at maturity, a state not uncommon in var. *johannensis* but elsewhere unknown in var. *terrae-novae.* It is possible that the two varieties run together in southwestern Newfoundland, but there is no difficulty in separating material from north and south of this area. Where the criteria stressed by Fernald (e. g. length of stipule-blades, of leaflets, raceme or bracts) fail, as they sometimes separately do, to distinguish the two, the short calyx-teeth have been taken as the principal diagnostic character of var. *terrae-novae.*

The reader is referred to Fernald's excellent account in Rhodora (l. c. 1928) for detailed discussion of the history of var. *johannensis* and for full citation of material.

15h. **Oxytropis campestris** (L.) DC. var. **chartacea** (Fassett) Barneby

Oxytropis campestris (L.) DC. var. *chartacea* (Fassett), comb. nov. *O. chartacea* Fassett, Rhodora, 38:95. 1936.

Similar in nearly every way to var. *johannensis,* but the pod shorter, 8–15 (as opposed to 14–27) mm. long, and the vesture of the whole plant more copious and looser, the stipules permanently pilose. *Type* collected by N. C. Fassett, in 1935, on the sandy shore of "Lake Huron," Plainfield, Wisconsin; Plainfield, Waushara County, *Fassett 16704* (GH, NY, OB, isotypes) !

Distribution: Sandy lake-shores, central and northwestern Wisconsin. Map 8.

Representative specimens: WISCONSIN. Pigeon Lake, Drummond, Bayfield County, *Fassett 16478* (N.Y.) Plainfield Lake, Waushara County, *Wadmond & Fassett 17386* (WTC), *Fassett 17385* (OB).

When better known var. *chartacea* may well be referred to var. *johannensis.* It is very poorly characterized.

16. **Oxytropis sericea** Nutt.

Cespitose, the numerous crowns clustered on a pluricipital caudex, the short branches of which are clothed with marcescent stipules and leaf-bases; herbage silky-pilose throughout with basifixed hairs, canescent (becoming tawny when dried) or rarely greenish; stipules pale, at first membranous and connate opposite the petiole, early ruptured and at length becoming chartaceous, the whole more or less pilose dorsally, sometimes subtomentose, 7–28 mm. long, the free blades deltoid to deltoid-acuminate, (2) 5–12 mm. long, hispid-ciliate, often glabrate in age; leaves commonly dimorphic 3.5–30 cm. long, with (9) 11–19 (25) opposite or somewhat scattered, ovate, ovate-oblong, elliptic or lanceolate, obtuse or acute leaflets (0.7) 1–4 cm. long, 2–10 mm. wide, laxly disposed along a rachis about twice as long as the appressed- or ascending-pilose petiole; scapes erect or ascending, 7–30 cm. long, commonly stout, equalling or often surpassing the foliage, pilose with appressed or some loosely ascending hairs; racemes 6–27-flowered, dense at first anthesis and oblong or subcapitate, either remaining so or more often becoming loose thereafter, the axis 1.5–18 cm. long in fruit; bracts lanceolate, herbaceous, 3–15 mm. long, pilose and sometimes also hirsute dorsally; pedicels at anthesis short, becoming 1–3 mm. long in fruit, not joined to the axis and hence usually long-persistent; calyx cylindro-campanulate, early ruptured, (6) 8–12.5 mm. long, the unequal teeth ¼–½ the length of the tube, the whole variously pubescent with light and dark hairs, either strigose, appressed-pilose, or hirsute with spreading and ascending hairs; petals white, ochroleucous, lemon-yellow (with or without a purple spot on the keel) or more rarely lilac-tinged or even purple throughout; banner 15–26 mm. long, the broad claw abruptly expanded beyond the calyx-tube into an oblong-obovate, deeply emarginate blade 8–12 mm. wide; wings 15–21 mm. long, the blades (including the auricle about 2 mm.) 9–13 mm. long, obliquely dilated upward and (4) 5–8 mm. wide near the emarginate apex; keel 13–19 mm. long, the blades (including the straight or recurved appendage 1–2 mm.) 7–11 mm. long; pod erect, sessile, the body narrowly oblong or ovoid-oblong, 1–2.5 cm. long, (3) 4–7.5 mm. in diameter, more or less obcompressed and sulcate ventrally, passing into a short, straight or somewhat divergent acuminate beak, the valves fleshy when fresh, becoming coriaceous or almost woody and rigid, densely silky-strigose or -pilosulous with short light or dark hairs, rarely subtomentose, or glabrate in age, the ventral suture produced inward as a complete or nearly complete false septum 1–2.5 mm. wide; seeds numerous, brown, 2–2.5 mm. long.

Oxytropis sericea is our only species in which basifixed vesture, coriaceous exserted pod, and white to pale yellow (occasionally purple) flowers are combined, but at one point or another it approaches and is difficult to separate, at least at first sight, from its near relatives. An occasional white-flowered form of *O. Lambertii* or, when only fruit is present, an exceptionally silky phase of that species simulate *O. sericea* closely, while the occasional purple-flowered individuals of *O. sericea* resemble *O. Lambertii* var. *Bigelovii.* But the presence of dolabriform hairs readily distinguishes *O. Lambertii* in all doubtful cases. With *O. campestris* var. *gracilis* there is no such convenient character. Although the flower is here usually smaller than that of *O. sericea,* the two overlap in this respect, and the texture of the pod sometimes becomes the only positive criterion yet discovered. Nevertheless, in spite of hybrids involving *O. sericea* and the other two which tend, especially in the herbarium, to cloud the issue, the cleavage between the three species is usually marked.

The species is quite variable, and an attempt was made during the studies leading to the present account to define several varieties; and two unpublished trinomials were freely used in annotating specimens. The first of these, based on *Aragallus pinetorum veganus* Ckll. was early abandoned. The type of this, from above timberline in the mountains of northern New Mexico, is a dwarf but robust plant with ample white flowers, loose vesture, and exceptionally long calyx-teeth. Similar forms had been seen from great altitudes in the Rocky Mountains as far north as Montana and Idaho, and seemed to represent a subalpine race which could and ought to be set apart. The long calyx-teeth, which at first offered a promising character, eventually proved fallacious, being correlated neither with alpine habitat nor with dwarf stature. In this respect a series of specimens collected by Rydberg and Vreeland in southern Huerfano County, Colorado, is instructive. These are closely similar in minor details of stipule, pubescence, calyx, and corolla, so much so that it is impossible to take them for anything but conspecific in the narrowest sense. A plant from 3000 meters on Iron Mountain (their *No. 6003,* NY) is dwarf and condensed, with short racemes barely emerging from the foliage, and is in everything an excellent match for the type of var. *veganus.* A second collection, from near La Veta at 2100 meters *(No. 6005,* NY) is a giant and ample thing with loose and elongated raceme far exserted on stout scapes. Yet another, also from near La Veta, *(No. 1004,* NY) is intermediate in development. Moreover several collections from subalpine levels with short calyx-teeth are now known, so that it becomes impossible to draw a line between typical *O. sericea* and var. *veganus.*

Quite polymorphic as to stature, color of flower, color and orientation of the vesture, and other characters, *O. sericea* is composed of many small races, several of which have received names from time to time. The variable factors are combined in many ways and with so little appearance of having achieved stability within a natural range that there seems to be no truly practical way of maintaining any of the possible segregates, beyond recognizing them as minor variants. Disregarding occasional aberrant or unusual plants, it is possible nevertheless to make out a fairly definite progression from the large plant of the southern prairies and the foothills of New Mexico *(Aragallus pinetorum)* with loose raceme of white flowers and maculate keel northward to a more compact state with immaculate, lemon-yellow and prevailingly smaller flowers in the Alberta Rockies *(Aragallus spicatus* or *A. Macounii).* The extreme conditions are readily recognizable, so that it has seemed best, in spite of complete intergradation, to accept a northern var. *spicata.* The following key does not pretend to take into account the many doubtful forms, especially prevalent in Montana, which combine some characters of each variety.

KEY TO THE VARIETIES OF O. SERICEA

1\. Petals white, ochroleucous or pale yellow, the keel often maculate with purple at apex 2

— Petals (white or yellowish) variously tinged with lilac, rose, or purple, sometimes bright purple throughout; hybrid forms of *O. sericea* with more or less genetic infection from *O. Lambertii,* or perhaps other species; cf. discussion below.

2\. Corolla white or rarely ochroleucous, the keel purple-tipped; raceme nearly always elongate, at least in fruit; s. Montana and South Dakota southward, mostly at middle altitudes in the mountains, or on the plains, to n.-e. Nevada, s. Utah, New Mexico, and Oklahoma, occasionally high montane to the south .... 16a. var. *sericea*

— Corolla pale yellow throughout, the keel concolorous; raceme tending to be short and compact; n. Wyoming and centr. Idaho to British Columbia and Manitoba, mostly montane toward its southern limit........................ 16b. var. *spicata*

16a. **Oxytropis sericea** Nutt. var. **sericea**

Oxytropis sericea Nutt. ex T. & G., Fl. N. Amer., 1:39. 1838. *O. Lambertii* var. *sericea* (Nutt.) Gray, Proc. Amer. Acad., 20:7. 1884. *Spiesia Lambertii* var. *sericea* (Nutt.) Rydb., Fl. Neb., 21:43, Pl. XI, fig. 107–109. 1895. *Aragallus sericeus* (Nutt.) Greene, Pittonia, 3:212. 1897. *A. Lambertii* var. *sericeus* (Nutt.) A. Nels., Erythea, 7:62. 1899, quoad. nom. (Non *Oxytropis sericea* (Lamk.) Simonkai, 1886).

Oxytropis Lambertii var. *ochroleuca* A. Nels., Bull. Wyo. Exper. Sta., 28:98. 1896. *Aragallus albiflorus* A. Nels., Erythea, 7:62. 1899. *Astragalus albiflorus* (A. Nels.) Gand., Bull. Soc. Bot. France, 48:xiv. 1901; Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937 (as "comb. nov."). *Oxytropis albiflora* (A. Nels.) K. Schum., Just's Jahresb., 27^{1}:496. 1901 (non *O. albiflora* Bge., 1874). *Aragallus saximontanus* A. Nels., Erythea, 7:190. 1899. *Oxytropis saximontana* (A. Nels.) A. Nels., Univ. Wyo. Pub. Bot., 1:113. 1926. *Astragalus saximontanus* (A. Nels.) Tidestr., Tidestr. & Kitt., Fl. Ariz. & New Mex., 216. 1941.

Aragallus albiflorus var. *condensatus* A. Nels., Erythea, 7:62. 1899. *A. saximontanus* var. *condensatus* (A. Nels.) A. Nels., op. cit., 190. 1900. *Oxytropis condensata* (A. Nels.) A. Nels., Univ. Wyo. Pub. Bot., 1:115 1926.

Oxytropis Lambertii "variety *lilacina*" Ckll., West. Amer. Sci., 5:11. 1888, nom. subnud.

Aragallus pinetorum A. Hell., Bull. Torr. Club, 26:548. 1899. *Oxytropis pinetorum* (A. Hell.) K. Schum., Just's Jahresb., 27^{1}:496. 1901.

Aragallus pinetorum veganus Ckll., Torreya, 2:155. 1902. *A. veganus* (Ckll.) Woot. & Standl., Cont. U. S. Nat. Herb., 16:136. 1913. *Oxytropis vegana* (Ckll.) Woot. & Standl., op. cit., 19:371. 1915.

Aragallus majusculus Greene, Proc. Biol. Soc. Wash., 18:12. 1905.

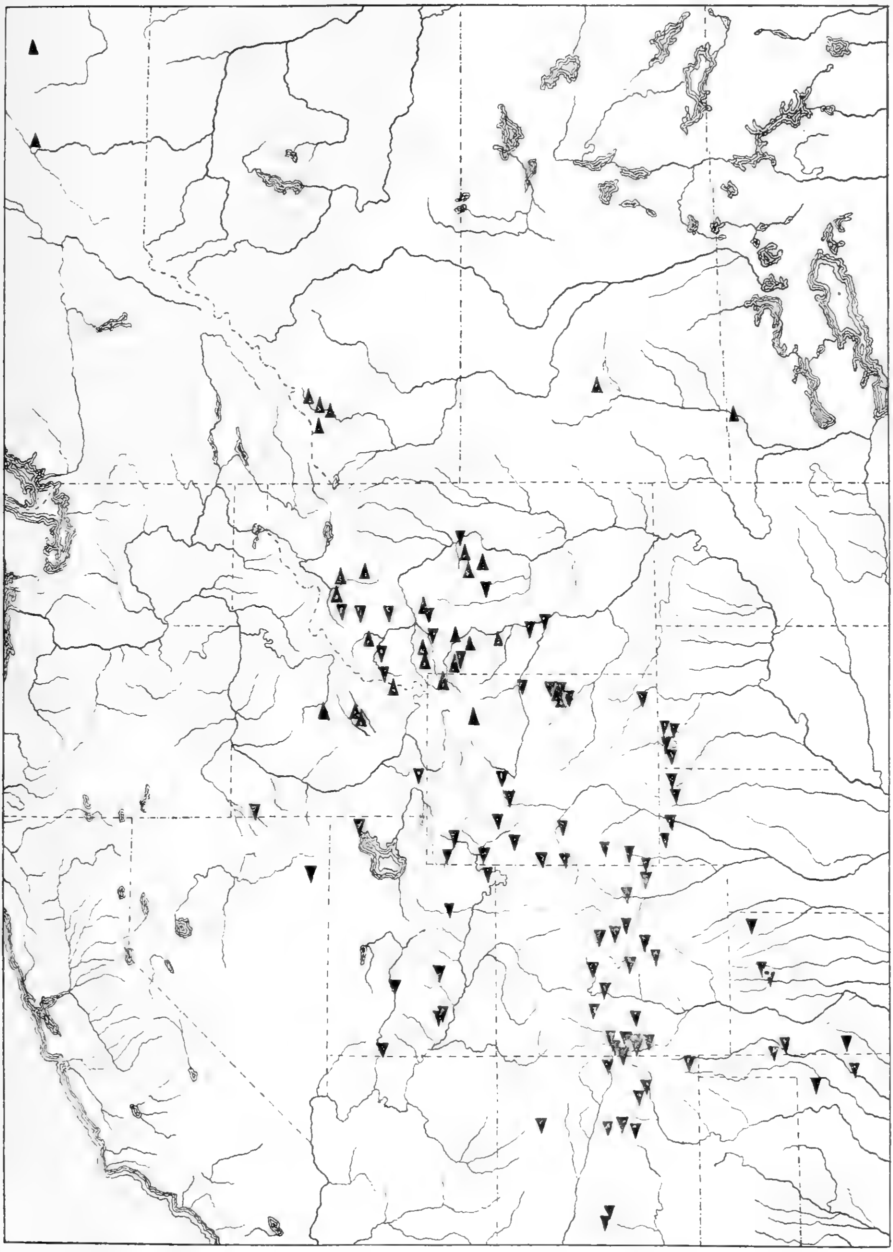
Aragallus aboriginum Greene, op. cit., 13. 1905.

Aragallus invenustus Greene, op. cit., 14. 1905.

As described for the species, but the corolla never pure yellow, commonly white or, if ochroleucous, the keel prominently maculate, rarely lilac or purple; plants tending to be robust, with open fruiting racemes; very variable, as discussed below. *Type* collected by Thomas Nuttall, in 1834, in the "Rocky Mountains"; Rocky Mts. towards the sources of the Oregon (doubtless southern Wyoming), *Nuttall* (NY)!

Distribution: Plains, prairies, and foothills of the Rocky Mountains, common from western Montana to the Black Hills of South Dakota, Oklahoma, central New Mexico, and occasional westward to northeastern Nevada, southern Utah, and southern Idaho, mostly between 3000 and 7000 ft. altitude, exceptionally reaching 11,000 ft. in the southern Rockies. Map 9.

Representative specimens: IDAHO. Caribou Mts. s.-w. of Swan Valley, *J. & C. Christ* (RB). MONTANA. 20 mi. e. of Fort Benton, Chouteau County, *Wilcox 27* (NY). W. of Virginia City, Madison County, *C. L. Hitchcock 15820* (RB, WTC). SOUTH DAKOTA. Hot Springs, Fall River County, *Rydberg 637* (NY, US). Black Hills near Fort Meade, Meade County, *Forwood 96a, 96b* (US, cotypes of *Aragallus invenustus*). WYOMING. Pole Creek,



Map 9. Range of *Oxytropis sericea:* var. *sericea* ▼; var. *spicata* ▲.

Albany County, *A. Nelson 119* (NY, isotype of *Aragallus Lambertii ochroleucus).* Hulett, Crook County, *M. Ownbey 603* (GH, IDS, NY, WTC). W. of South Pass City, Fremont County, *C. L. Porter 4546* (RB, calyx villous, perhaps passage to *O. nana).* Bitter Creek, Sweetwater County, *A. Nelson 4773* (NY, US, isotypes of *Aragallus albiflorus condensatus).* N. of Lyman, Uinta County, *Rollins 2239* (GH, NY, WTC). NEBRASKA. Fort Robinson, Dawes County, Bates 1069 (NY, flowers purple). Scotts Bluff, Scotts Bluff County, *Rydberg 63b* (NY). NEVADA. East Humboldt Mts., Elko County, *M. E. Jones in 1900* (POM). UTAH. W. of Duchesne, Duchesne County, *Ripley & Barneby 4680* (CAS). Mt. Ellen, Henry Mts., Garfield County, *M. E. Jones 5674* (US, type of *Aragallus majusculus,* NY). Kanab, Kane County, *M. E. Jones in 1894* (POM, depauperate). COLORADO. Sangre de Cristo Range, alpine, *Brandegee 886* (NY, depauperate). Everett, Lake County, *Clokey 3537* (CAS, NY, POM, US, WTC). Divide, Teller County, *Clokey 3809* (CAS, flowers white or purple, NY, POM, WTC, flowers purple). KANSAS. Jennings, Decatur County, *Ripley & Barneby 8289* (WYO). Turkey Creek, e. of McAllester, *Rydberg & Imler 1144* (NY). NEW MEXICO. Llano Estacado, *Bigelow in 1853* (GH, US). Top of Las Vegas Range, *Cockerell 20* (NY, type of *Aragallus pinetorum veganus).* E. of Las Vegas, San Miguel County, *Ripley & Barneby 7525* (CAS, NY). S.-e. of Santa Fe, Santa Fe County, *A. & E. Heller 3751* (GH, ND, NY, OB, POM, US, WTC, isotypes of *Aragallus pinetorum).* OKLAHOMA. Cimarron Valley, Cherokee Outlet, *Carleton 217* and Indian Territory, *Carleton in 1891* (US, cotypes of *Aragallus aboriginum).* Cora, Woods County, *Stevens 218* (GH, NY, US).

Although one of the commonest and most characteristic plants of the easterly slope of the Rockies, and described as a species more than a century ago, *O. sericea* has had an oddly obscure and complicated taxonomic history. Nuttall's type is in advanced fruit, the color of the petals therefore unknown, and it has generally been interpreted as a silky phase of purple-flowered *O. Lambertii,* but the basifixed hairs and woody pod leave no doubt as to its identity. The species is abundant and not easily overlooked in the drainage of the North Platte, and it would be odd indeed if Nuttall, with his perspicacious eye, had failed to encounter it. Reports of early travellers (such as Geyer; cf. Hook., Jour. of Bot., 6: 212, 1847, as *O. campestris β speciosa)* tell repeatedly of the white and purple locoweeds growing together, as they still do, on the prairies, where they were taken for color-forms of one species. This opinion was no doubt corroborated by the variation in color, from white to pale lilac and various tones of purple, found in some colonies of both *O. sericea* and *O. Lambertii.* These are believed to be the progeny of past hybrids and are often unusually robust and large-flowered. In any case Gray, having reduced *O. sericea* to *O. Lambertii* in his first revision (1864), revived it in the second (1884) as a variety, his concept at this time being of a large, copiously silky *(O. pinetorum)* phase, and he made no distinction as to color of the flowers. It so came about that with few exceptions *O. sericea* was thought to be no more than a strongly pubescent state of *O. Lambertii* and that *O. Lambertii* was as often as not white-flowered, an assumption which led Cockerell to distinguish as "*O. Lambertii* variety *lilacina*" the colored form of *O. sericea* which he knew in Custer County, Colorado. As *O. Lambertii* became better known, a distinction between more and less canescent states became untenable, and *O. sericea* was thus generally relegated to synonymy.

In his latest paper on the genus (1926) A. Nelson did take up *O. sericea* as a species, said to differ from *O. Lambertii* in the insubstantial character of "pink or pale purple" as opposed to "dark purple" flowers, but the material cited is a mixture of *O. Lambertii* var. *Bigelovii* and *O. Besseyi* var. *ventosa*. It has not been established exactly what Rydberg finally (Fl. Prair. & Pl., 484, 1932) had in mind as *O. sericea.*

The first recognition of a white-flowered species came in 1896, when Nelson, who knew it in the field, described his *O. Lambertii* var. *ochroleuca,* designating it "a good and constant variety, if not species." He soon raised this to specific rank as *Aragallus albiflorus,* for which he quickly substituted the epithet *saximontanus,* proposed in order to avoid competition with an earlier *Oxytropis albiflora,* though it was superfluous in *Aragallus.* When *Oxytropis* was placed on the list of *genera conservanda,* Nelson was able to make the further transfer to *O. saximontana.* However, in 1899 Heller had published on another type his *Aragallus pinetorum,* supposedly distinct from *A. albiflorus* (but here held synonymous), and this, although of later date than *A. albiflorus,* has a narrow priority over *A. saximontanus.* These three epithets, under various genera, have all found currency in the literature and especially in herbaria, and there has been widespread uncertainty as to the proper label for the white loco. But Nuttall's old and appropriate *O. sericea* antedates them all by many years.

The segregates here reduced to var. *sericea* are not all precisely similar, but seem to mark no more than random points on a scale of modification normal in the genus. The principal modes of variation can be described as follows:

Stature. Between the rather common "gigas" phase *(O. pinetorum, O. saximontana* and *A. majusculus),* with open raceme, tall scape, and ample foliage, and the relatively condensed, low, small-flowered desert extreme *(O. condensata)* every sort of intermediate is found and little significant geographic correlation. The large plant is perhaps more prevalent southward, but occurs sporadically north to central Montana, near the limit of the variety as a whole. It remains to be shown whether it is purely a response to favorable conditions or whether polyploidy is involved. The size of the leaflets (with extremes of 1 and 4 cm. in length) is not correlated with their number or with the plant's stature, with length of raceme or other characters.

Pubescence. In the type of *A. pinetorum* from Santa Fe County, New Mexico, the scapes are copiously ascending-hirsute; in that of *A. albiflorus* from Wyoming they are, like the whole plant, appressed-pilose. But in other material from near Santa Fe *(A. & R. Nelson 2201)* the loose hairs are few, while villous scapes occur here and there throughout the variety's range. In most collections from the southern prairies (Kansas, Oklahoma, New Mexico) the stipules are all permanently pilose dorsally, but even here, as commonly elsewhere, the blades may be glabrate. The vesture of the calyx in a collection from Wyoming *(A. Nelson 3146)* is instructive: in one plant white-pilose and lacking hirsute hairs, in another black and white-strigose, with prominently nigrescent teeth and some hirsute hairs on the tube. Transitional states in color, length and orientation of the calyx-hairs is everywhere apparent.

Corolla. The banner is normally about 2 cm. long and half or a little less as wide, but exceptionally ample or long petals are not infrequent *(A. Nelson 3146),* and rarely the banner is as little as 16 mm. long *(Ripley & Barneby 8159)* and proportionately narrow. The degree to which the blades of the wing-petals are dilated upward is equally variable. No peculiarity of the flower has been found linked with another character of importance. Plants with many dark hairs in the inflorescence are more likely to bear ochroleucous flowers, those with a preponderance of pale hairs pure white flowers; but even here exceptions are numerous.

Pod. The pod is commonly about twice the length of the calyx and 5 mm. in diameter. In dry situations it may be much shorter, and occasionally (as in the type of *A. majusculus)* reaches a width of 7 mm. There exists a complete series between the extremes in otherwise like plants. In all fresh material examined the pod has been bilocular at and below the middle, but its valves are fleshy and as they dry out the walls shrink and a gap appears between the free edge of the false septum and the dorsal suture. The legume then appears imperfectly bilocular, and is perhaps truly so at times. The septum is about 2 mm. wide as a rule, but varies considerably in absolute width, this apparently correlated with the depth of the ventral sulcus and the degree of obcompression of the pod.

16b. **Oxytropis sericea** Nutt. var. **spicata** (Hook.) Barneby

Oxytropis sericea Nutt. var. *spicata* (Hook.) Barneby, Leafl. West. Bot., 5:111. 1951. *O. campestris δ spicata* Hook., Fl. Bor.-Amer., 1:147. 1834. *Aragallus spicatus* (Hook.) Rydb., Mem. N. Y. Bot. Gard., 1:251. 1900, pro parte, exclus. syn. *Oxytropis spicata* (Hook.) Pammell, Man. Pois. Pl., 2:569. 1911, nom. nud. *O. spicata* (Hook.) Standl., Cont. U. S. Nat. Herb., 22:373. 1921.

Oxytropis campestris γ sulphurea sensu Hook., Fl. Bor.-Amer., 1:147. 1834; non DC. *O. campestris β speciosa* T. & G., Fl. N. Amer., 1:341. 1838.

Aragallus Macounii Greene, Proc. Biol. Soc. Wash., 18:16. 1905, pro parte; Dayton, op. cit., 40:120. 1927, exclus. syn. ult. *Oxytropis Macounii* (Greene) Rydb., Fl. Pr. & Pl., 485. 1932.

Aragallus melanodontus Greene, Proc. Biol. Soc. Wash., 18:15. 1905.

Similar to var. *sericea,* commonly low, the scapes 7–15 (25) cm. long; stipules either permanently pilose dorsally or (at least those subtending the secondary leaves) glabrate, the free blades either strongly hispid-ciliate or bearing a few apical hairs; leaflets 11–15 (17), 7–22 (30) mm. long; calyx silky-pilose with mixed pale and dark hairs, the longer hairs sometimes lacking and then dark-strigose, the tube 6–8 mm., the nearly always nigrescent teeth (1.5) 2–3 mm. long; corolla pale yellow throughout, the banner 18.5–23 mm. long, 7–10.5 mm. wide; wings 14–19 mm. long, the blades strongly dilated upward and 5–7 mm. wide near apex; keel immaculate, (13) 14–16 mm. long; pod 16–25 mm. long, leathery, shortly pubescent with either mixed or wholly black hairs. *Type* collected by Drummond, between Carlton House on the Saskatchewan and the Rocky Mountains (probably Alberta); "*O. campestris* δ *spicata* ex herb. Hook." (GH, NY, presumed isotypes)!

Distribution: Prairies and gravelly hillsides, in dry or exposed places, often on talus in the mountains, western Manitoba to British Columbia (in the drainage of the Mackenzie River) south to central Idaho and northern Wyoming. Map 9.

Representative specimens: Without locality, "*O. campestris* γ ex herb. Hook" (NY, mounted with δ *spicata,* presumed type of var. β *speciosa* T. & G.). BRITISH COLUMBIA. Mouth of Wicked River, lat. 58° 3′ N., *Raup & Abbe 3844* (GH, NY). ALBERTA. Elbow River, *Macoun 18513* (ND, type of *Aragallus melanodontus).* Calgary, *Macoun 18516* (ND, lectotype of *Aragallus Macounii).* Tunnel Mt. near Banff, *McCalla 2127* (NY, US, WTU). SASKATCHEWAN. Old Wives Creek, *J. Macoun in 1895* (POM). MANITOBA. Qu'Appelle River, *Macoun & Herriott 70799* (GH, NY, POM). MONTANA. N. of Philipsburg, Granite County, *Hitchcock & Muhlick 9141* (CAS, GH, WTC, WTU). Yogo Peak, Little Belt Mts., Judith Basin County, *Hitchcock & Muhlick 16159* (RB, WTC). Old Hollowtop near Pony, *Rydberg & Bessey 4505* (GH, NY). IDAHO. Mahogany Creek, Lost River Mts., Custer County, *Hitchcock & Muhlick 11020* (GH, NY, WTC, WTU, keel purple-tipped). Ryan Peak, Custer County, *Hitchcock & Muhlick 10620* (CAS, GH, NY, WTC, WTU). WYOMING. The Thunderer, Yellowstone Park, *A. & E. Nelson 5813* (GH, NY, POM, US). Big Horn Mts. above Dayton, Sheridan County, *Ripley & Barneby 8028* (CAS).

In the foothills of the Canadian Rocky Mountains var. *spicata* is rather well marked by its medium-sized, yellowish corolla, predominantly dark-hairy calyx, and, as a rule, densely pilose primary stipules. The pod is a trifle thinner in texture than that of var. *sericea,* and its septum is often less pronounced, at times barely traversing half the width of the cavity, but sometimes complete. As the variety passes southward into Montana it intermingles and intergrades with var. *sericea* and the immaculate keel seems in some cases to be the only useful, though essentially superficial character. Among the extensive collections of forms collected by Hitchcock and Muhlick in the mountains of Idaho and Montana there are many that seem quite intermediate between var. *sericea* and var. *spicata* and these can only be arbitrarily assigned to one or the other. In the Big Snowy Mountains they found plants with flowers "pale yellow" *(No. 11912)* and "white and pink-lined to very pinkish in general aspect" *(No. 11919)* growing close at hand; whereas several collections from above timberline in Custer County, Idaho, combine the general stature and facies of var. *spicata* with pale yellow petals and maculate keel. Rydberg (Fl. Rocky Mts., 522, 1917) separated *Aragallus albiflorus* (var. *sericea)* from *A. spicatus* on the characters of the latter's yellow petals, narrow wings and nearly bilocular pod, as opposed to white or straw-colored petals, broad banner and wings ("fully 1 cm. wide"), and semi-bilocular pod of *A. albiflorus.* It is true that the petals are usually somewhat narrower in var. *spicata,* but we have examples of yellow flowers with banner over 1 cm. wide and of white flowers with banner not more than 7.5 mm. wide. The development of the septum is variable in both yellow and white-flowered (otherwise similar) plants, but it tends to be, if anything, narrower and less complete in var. *spicata.*

Considerable difficulty is met with in separating var. *spicata* from *O. campestris* sensu lato, especially when the pod is lacking. In fact no clean dividing line can then be drawn between the two. The commonest phase of *O. campestris* occurring in the range of var. *spicata* is *O. campestris* var. *gracilis,* as a rule distinguished by its numerous leaflets, much smaller corolla with narrower wing-petals, and by its more sparsely pilose and hence greener herbage. But occasional plants of undoubted var. *gracilis,* with the papery legume of the *O. campestris* alliance, may have relatively few (17) leaflets, banner up to 19 mm. long, wing-petals dilated and up to 5 mm. wide, or densely and permanently silky foliage and heavily pilose stipules. The "*cervinus*" state of var. *gracilis* (more fully discussed under that heading) bears a corolla quite as ample as average var. *spicata,* and leaflets as few as 13 to the leaf. A few dwarf flowering specimens from subalpine habitats in Montana (cf. Tobacco Root Mts., *C. L. Hitchcock 16962)* seem to be depauperate var. *spicata,* but closely resemble *O. campestris* var. *Cusickii* in habit and reduced raceme, and it is difficult to be sure of their proper place in absence of the legume. It will be seen, in any case, that var. *spicata* occupies a critical position between the predominantly southern and lowland *O. sericea* and the mostly northern and montane *O. campestris,* and forms a link between the latter widely dispersed and complex circumboreal species and the presumably derived, purely North American *O. sericea.*

In the circumstances it is hardly surprising that var. *spicata* was at first subordinated by Hooker to a widely inclusive *O. campestris,* from which it was said to differ only in the loosely flowered and elongate spike. Specimens of an *Oxytropis* with open raceme, communicated by Hooker, are preserved in the herbaria of Gray and Torrey under the label "*O. campestris* δ Hook.," and have been taken as authentic for the var. *spicata* of Flora Boreali-Americana, presumably collected by Drummond in Canada. Mounted with this in the Torrey Herbarium is a smaller plant with condensed raceme and somewhat shorter leaves (but otherwise similar), no doubt the *O. campestris* γ *sulphurea* of Hooker. Since the length of the raceme and leaves prove to be inconsiderable differences, and the plants are alike in details of corolla, stipule, and vesture, Hooker's two varieties are believed to be synonymous. Both types are matched by modern Canadian material with leathery legume and doubtless belong to the taxon under discussion.

Except for their appearance in a few early lists and in Torrey and Gray's *Flora* (where var. *sulphurea,* rightly considered different from the original var. *sulphurea* Fisch. ex DC.[14], was renamed var. *speciosa),* the idea of Hooker's varieties suffered a long eclipse. Neither is mentioned in Gray's first revision (1864), but it is stated in the second (1884) that var. *spicata* "seemed . . . to belong to *O. Lambertii,*" and from annotations it is clear that Gray was treating both as part of his much too inclusive *O. Lambertii.* Rydberg revived var. *spicata* (as *Aragallus)* in 1900, and reduced to it the earlier *A. albiflorus,* a procedure justified by the nomenclatural code then in fashion. Subsequently the specific epithet was twice used in *Oxytropis,* by Pammel (1911) and by Standley (1921). The first was a *nomen nudum,* and the second, owing to lack of citation of the basonyn (there was a reference only to "*Aragallus spicatus* Rydb.") was so considered by Dayton, who took up for the same *Aragallus Macounii* Greene. This species was based on two collections from near Calgary, Alberta, *Macoun 18516* and *18517.* The first, which is undoubtedly var. *spicata,* is here taken as lectotype; the other belongs to *O. campestris* var. *gracilis. Aragallus melanodontus* Greene is merely the common dark-hairy state of var. *spicata.*

17. **Oxytropis nana** Nutt.

Oxytropis nana Nutt. ex T. & G., Fl. N. Amer., 1:340. 1838. *Spiesia nana* (Nutt.) O. Kze., Rev. Gen., 206. 1891. *Aragallus nanus* (Nutt.) Greene, Pittonia, 3:212. 1897. *Astragalus Tomae* Tidestr., Proc. Biol. Soc. Wash., 50:18. 1937 (non *A. nanus* DC.).

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[14] *Oxytropis campestris* var. *sulphurea* Fisch. ex DC., Prod.., 2:278. 1825, based on a plant of Altai, was described as very close to European *O. campestris,* but as having larger flowers. It was accepted as a species by Ledebour, and it is beautifully figured in Ic. Fl. Ross. Pl. 55. 1829. A specimen from Fischer in the Torrey Herbarium is a good match for the plate and is probably authentic var. *sulphurea.* It does not closely resemble any native American species.

Aragallus collinus A. Nels., Erythea, 7:57. 1899, pro parte, exclus. char. fruct. *Oxytropis collina* (A. Nels.) K. Schum., Just's Jahresb., 27¹:496. 1901. *O. Lunelliana* A. Nels., Univ. Wyo. Pub. Bot., 1:117. 1926[15].

Densely cespitose, silky-pilose throughout, silvery or sometimes greenish; stipules membranous and connate opposite the petiole but early ruptured, 8–15 mm. long, the deltoid to deltoid-lanceolate free blades 3–6 mm. long, the whole densely and permanently silky-pilose dorsally, rarely glabrate distally, at length becoming chartaceous and persistent; leaves somewhat dimorphic, 2–9 (11) cm. long, the petioles 1–4 (5) cm. long, pilose with subappressed and loosely ascending hairs; leaflets 7–11 (13), narrowly to broadly lance-oblong, lanceolate or elliptic, 5–30 mm. long, acute or on the primary leaves sometimes obtuse; scapes erect or arcuate-ascending, 3–10 (15) cm. long, ascending-pilose; racemes 5–19-flowered, dense at first, at full anthesis oblong to subcapitate, the axis becoming looser and 1.5–5 (7) cm. long in fruit; bracts narrowly ovate to lanceolate, 4–10 (15) mm. long, herbaceous, densely pilose dorsally; calyx so densely shaggy-hirsute and subtomentose with white hairs as completely to conceal the surface, cylindro-campanulate in early anthesis, soon becoming inflated and urceolate, 9–11 mm. long, the teeth subulate-deltoid, pubescent within, 1.5–2.5 (3) mm. long, the whole in fruit 11–16 mm. long, constricted at the mouth, the teeth then erect or connivent; pedicels 1 mm. long or less, not jointed to the axis; petals purple, or white with a purple-spotted keel; banner 18–22.5 mm. long, the oblong-obovate blade (6) 8–15 mm. wide; wings nearly as long, the blades obliquely dilated upward, 12–14 mm. long, (4.5) 6–9 mm. wide near the truncate-emarginate apex; keel 15–17 mm. long, the blades 9.5–10 mm. long, including the straight or slightly declined appendage; pod subsessile, included in the calyx and tardily deciduous with it, the ovoid, obcompressed body 7–10 mm. long, 4–5 mm. in diameter, passing into an acuminate beak about 5 mm. long, somewhat sulcate ventrally, the valves coriaceous, rigid, strigose-canescent, the seminiferous suture produced as a false septum 0.3–1.5 mm. wide; seeds olive-brown, 1.8–2 mm. in diameter. *Type* collected by Thomas Nuttall, in 1834, on the "Plains of the Platte in the Rocky Mountain Range" (i. e. Wyoming); "R[ocky] Mts.," *Nuttall* (PH, NY)!

Distribution: Open limestone, shale or cobblestone bluffs and hilltops, between 6600 and 10,000 ft. altitude in the drainage of the North Platte and Cheyenne rivers, westward to the Wind River Range, Wyoming. Map 6.

Representative specimens: WYOMING. Seminoe Mts., Carbon County, *E. Nelson 4925* (GH, NY, US, isotypes of *Aragallus collinus*). 14 mi. n. of Rawlins, Carbon County, *Ripley & Barneby 7745* (CAS, NY). N.-w. of

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[15] A substitute for *O. collina* K. Schum.; but the supposed obstacle, *O. collina* Turcz., Bull. Soc. Nat. Mosc., 25:741, 1842, was merely listed by Turczaninow as a synonym, and no evidence of subsequent validation has been traced.

Orin, Converse County, *Ripley & Barneby 8958* (CAS). Alcova, Natrona County, *Goodding 147* (NY, POM). Platte River Canyon above Goose Egg, *Ripley & Barneby 8938* (CAS, NY, WYO). N.-e. of Rochelle, Weston County, *C. L. Turner 91* (RB).

Oxytropis nana is a species of restricted range which has been consistently misinterpreted and virtually lost sight of since Nuttall's day. The most perfect example of the type-collection which has been studied is that in the Torrey Herbarium, and consists of a dwarf plant with two capitate racemes of young, relatively large purple flowers (the wings and banner 18 mm. long), short leaves with seven leaflets, and broadly cylindro-campanulate, silky-pilose calyx with tube 7 mm. and teeth 2 mm. long. It is matched at all points by the smallest flowering individuals in a collection *(Ripley & Barneby 8952,* CAS, NY, WYO) from chalky shale ridges on the Platte above Alcova, and since this station is quite near Nuttall's route through Wyoming, the identity of his original gathering seems well established. This being so, the epithet *nana* becomes something of a misnomer, for the depauperate type gives no indication of the luxuriance and size of well nourished plants. Recent collections from the North Platte valley in Natrona and Converse counties exhibit a complete sequence ranging from the diminutive equivalent of the type into a relatively giant thing with oblong inflorescence held on stout peduncles up to 15 cm. tall. There seems no essential difference between the large extreme of *O. nana* and the type of *A. collinus,* except for the latter's white corolla. The type of *A. collinus,* from about 10,000 feet in the Seminoe Range, not more than twenty miles south of Alcova, is more ample in the leaf than most of purple-flowered *O. nana.* Only one collection (10–15 mi. s. of Lander, Fremont County, *T. & F. Craig 3552,* POM) has been seen which exactly duplicates *A. collinus;* but the ventricose-inflated calyx, dimensions of the petals and forming legume are in no way different from those of *O. nana.* Moreover, we have white-flowered material from the southern foothills of the Seminoe Range (Rawlins, Parco) which, while maintaining the coloring of *A. collinus,* varies in stature and amplitude of leaf down to a depauperate extreme otherwise inseparable from the original *O. nana* of Nuttall. And in plants from Muddy Gap on a spur of the Ferris Mountains, a western prolongation of the Seminoe Range *(Ripley & Barneby 9134,* CAS, WYO) the fresh flowers were white flushed with pink at the base of the banner and wings. So far we have no evidence that purple and white flowers occur in the same population, as happens in the polychrome races of *O. sericea* and *O. Lambertii.* The question arises, nevertheless, as to whether *O. nana* was not originally of hybrid origin, and it does seem possible that a cross between *O. sericea* and *O. multiceps* might inherit the necessary characters, from the first the white corolla and coriaceous pod, from the second the purple corolla and inflated calyx. An attempt should be made to obtain an example of *O. nana* experimentally by controlled hybridization. In any case *O. nana* is certainly established as a self-perpetuating species at the present time.

The name *O. nana* has been applied to diverse species and, by accretion of extraneous elements, has become altogether vague and ambiguous. In his first revision (1864) Gray referred to it Cooper's plant from Montana which much later became the type of *O. Besseyi* var. *argophylla;* in his second (1884) he added more of the same *(Watson 94,* GH), and described the fruit from *Parry 91,* a specimen of *O. Lagopus.* By coincidence this happens to have a small pod enclosed in the inflated calyx similar to that of true *O. nana* (of which fruit was at the time unknown), but the pod is of thinner texture, villous, and the flower is smaller. These errors have persisted, and current descriptions of *O. nana,* derived at least in part from Gray's mixed concept, portray a chimerical mixture of *O. Besseyi* and *O. Lagopus.*

18. **Oxytropis Lambertii** Pursh

Cespitose, the few to many crowns sessile on the summit of a stout taproot or on the short clustered divisions of the caudex; pubescence dolabriform, usually subappressed-pilose, sometimes looser and hirsute or villous, sparse to very copious, the herbage thus silky-canescent or greenish; stipules pale, at first membranous and connate opposite the petiole, early ruptured and at length becoming chartaceous and persistent, 7–24 mm. long, pilose or even sericeous dorsally, or those of the secondary leaves commonly glabrate, the deltoid to deltoid-acuminate, sometimes subherbaceous free blades 2–9 mm. long; leaves strongly dimorphic or subhomomorphic, but the primary nearly always shorter, (2.5) 5–21 cm. long, erect or spreading, the petioles and rachis appressed-pilose, glabrate, or bearing some loosely ascending hairs; leaflets (3) 7–15 (19), linear, lance-linear, elliptic or ovate, acute or acutish, when narrow usually falcate, membranous or thick and rigid, the margins variously elevated or involute; scapes erect or ascending, 5–25 cm. long, commonly surpassing the leaves; racemes (6) 10–25-flowered, either dense or lax, (2) 2.5–3.5 (4) cm. wide at full anthesis, the flowers subhorizontal to nearly erect, the axis elongating and becoming (2) 4–17 cm. long in fruit; bracts herbaceous, lanceolate to ovate-acuminate, 2–10 mm. long, more or less pilose dorsally; pedicels very short; petals pink-purple, rarely white, or of many intermediate shades of rose, lavender, and purple; calyx cylindric, (6.5) 7–11 mm. long, the purplish tube silky-strigose or -pilose, rarely with some dark or some loose hairs, the subulate to triangular-subulate teeth 1.2–4 mm. long; banner (13) 15–25 mm. long, the emarginate, somewhat fiddle-shaped blade 8–12 mm. wide; wings 13.5–20 mm. long, the oblique blades variably dilated upward, 5.5–8 mm. wide near the truncate or emarginate apex; keel (12) 13–19 mm. long, the straight or slightly arched appendage 1–2 mm. long; pod sessile or shortly stipitate, long persistent and dehiscent on the raceme, ovoid to lance-acuminate in outline and passing upward into an erect or abruptly divaricate, conic or acuminate beak, more or less obcompressed and strongly sulcate ventrally, the valves coriaceous to woody, strigose-silky or merely strigulose, the seminiferous suture produced across the cavity as a complete or nearly complete partition; seeds dull brown, 1.9–2.1 mm. in diameter.

The purple loco, in the large sense, is distinguished from all American (and perhaps Old World) species of its genus by the dolabriform attachment of the pubescence. In its most pubescent phase it resembles the usually white or pale yellow-flowered *O. sericea,* like it in the leathery texture of the pod. On the eastern slope of the Rockies, and occasionally westward, the two species grow together, and can be separated with certainty, after the flowers are past, only by the form of the vesture. But as a rule, and disregarding the polychrome hybrids more fully discussed below, *O. Lambertii* is distinguished by its purple corolla. The species presents many problems.

In their *Illustrated Flora,* Britton and Brown were able to accept from their area only a single species in the *O. Lambertii* complex, though they remarked that this consisted ''of several races, differing in amount of pubescence, shape and size of leaflets, color of flowers, and shape of pods.'' Several attempts have been made to define these races. For example, Rydberg recognized five species as occurring in the Rocky Mountains and adjacent plains, and Nelson six from the prairies alone, with two more from the mountains to the west. The criteria stressed by these authorities cannot be applied to any representative suite of specimens, as one or two examples of the many that spring to mind will help to show. Rydberg separated *Aragallus Lambertii* from *A. angustatus* on the basis of its erect, not spreading leaves; its slightly longer, straight legume; and its longer corolla, with banner 18–20 (as opposed to 15) mm. long. Unfortunately in part of the type of *A. angustatus* the foliage is erect; short, straight pods and longer pods with divaricate beak are found in otherwise similar plants; while the banner of Pursh's original *O. Lambertii* is only 15–17 mm. long. In Nelson's key we find the ''Blue Loco,'' *O. patens,* placed in a group characterized by ''pod suberect, with spreading beak''; but in the type of this species, part of which was cited by Nelson, the legumes spread from the axis of the raceme at a wide angle (whence the epithet *patens),* and are nearly straight, as indeed Rydberg originally described them. It was found possible to identify from Nelson's and Rydberg's keys less than half of the hundred-odd collections of *O. Lambertii* in the New York Botanical Garden, and even then the determinations were seldom in agreement. The criteria adduced by these authors in support of their segregate species are evidently of a trivial nature. In *O. Lambertii* the length of the scape and of the raceme, the orientation of the leaves and pods, the absolute size and width of the petals and their length relative to the calyx, the length of the pod and the curvature of its beak are all variable within a single and presumably monophyletic population. When several characters diverge together from the normal or average state, the result is striking; but since the observed differences occur in every sort of combination, a segregate based on any one or two of them has no solid basis as species.

While no more than a single species can be made out in the multitudinous races and aspects of *O. Lambertii,* definite geographical trends exist. Thus plants from the prairies, from Manitoba to Texas, are almost invariably characterized by long and narrow leaflets and a toughly coriaceous or woody pod. To the north the prevailing phase has rather thin and flaccid stems and herbage, and the pod is commonly well exserted from the calyx at maturity, whereas to the south this passes into populations with thick and rigid leaflets, and shorter, scarcely exserted pod. Exceptions to this general rule are noted under the appropriate heading below. In cordilleran *O. Lambertii* the leaflets are nearly always of a broader type and the pod is less firm in texture and often stipitate. The intergradation between the prairie and montane types is complete where the plains climb westward into the foothills of the Rockies, and occasional individuals from well within the territory of each exhibit the leaflet outline prevalent in that of the other. Nonetheless the quantity of material which falls into either category is impressive, and even though it is not possible to define them in exact terms, they may conveniently be accepted as geographic varieties. It should be emphasized that the ensuing key does not cover every individual to be met with in nature, but it can be usefully applied to a large proportion of the material examined.

KEY TO THE VARIETIES OF O. LAMBERTII

1. Pod strictly sessile.......... 2

— Pod stipitate.......... 18c. var. *Bigelovii*

2. Leaflets of the developed secondary leaves narrowly linear-lanceolate or linear, commonly elongate, 5–10 times as long as their greatest width; pod toughly leathery or woody; plants of the prairie states, Manitoba to Texas.......... 3

— Leaflets of the developed secondary leaves of a broader type, elliptic or ovate, about 3–5 times as long as their greatest width; pod of thinner texture; plants of the Rocky Mountain states, Wyoming to New Mexico and s. Arizona.......... 18c. var. *Bigelovii*

3. Calyx-tube about 3 times longer than the teeth; corolla relatively small, the banner 18 mm. long or less; body of the pod about twice as long as the calyx; herbage and scapes commonly thin and flaccid; Kansas northward.......... 18a. var. *Lambertii*

— Calyx-tube 4–5 times longer than the teeth; corolla large, the banner 18–25 mm. long; body of the pod about equalling the calyx or, if exserted, the calyx-teeth very short; scapes and leaflets usually thick and rigid; Oklahoma and Texas.......... 18b. var. *articulata*

18a. **Oxytropis Lambertii** Pursh var. **Lambertii**

Oxytropis Lambertii Pursh, Fl. Amer. Sept., 740. 1814. *Astragalus Lambertii* (Pursh) Spreng., Syst., 3:308. 1826. *Spiesia Lambertii* (Pursh) O. Kze., Rev. Gen., 206. 1891. *Aragallus Lambertii* (Pursh) Greene, Pittonia, 3:212. 1897.

Oxytropis Lambertii γ T. & G., Fl. N. Amer., 1:339. 1838.

Oxytropis Hookeriana Nutt. ex T. & G., op. cit., 340. 1838.

Oxytropis plattensis Nutt. ex T. & G., loc. cit., 1838.

Aragallus involutus A. Nels., Erythea, 7:64. 1899. *Oxytropis involuta* (A. Nels.) K. Schum., Just's Jahresb., 27^1:496. 1901.

Oxytropis Bushii Gand., Bull. Soc. Bot. France, 48:xvii. 1901.

Aragallus falcatus Greene, Proc. Biol. Soc. Wash., 18:13. 1905. *Oxytropis falcata* (Greene) A. Nels., Univ. Wyo. Pub. Bot., 1:118. 1926.

Aragallus formosus Greene, Proc. Biol. Soc. Wash., 18:13. 1905.

Aragallus rigens Greene, op. cit., 14. 1905.

Aragallus angustatus Rydb., Bull. Torr. Club, 34:422. 1907. *Oxytropis angustata* (Rydb.) A. Nels., Univ. Wyo. Pub. Bot., 1:116. 1926.

Aragallus Aven-Nelsonii Lunell, "Bull. Leeds Herb., 2:6. 1908," reprinted in Fedde, Repert. Sp. Nov., 8:245. 1910. *Oxytropis Aven-Nelsonii* (Lunell) A. Nels., Univ. Wyo. Pub. Bot., 1:116. 1926.

Oxytropis Lambertii fma. *mixta* Gand., Bull. Soc. Bot. France, 48:xvii. 1901, pro parte.

Commonly thinly pilose and greenish, sometimes silky-canescent throughout, the hairs appressed, or the scapes and petioles often ascending-hirsute, the vesture becoming tawny when dry; stipules thinly to densely pilose dorsally, the free blades commonly glabrate; leaves more or less dimorphic, (2) 5–17 (23) cm. long, with (5) 9–19 linear, linear-lanceolate or narrowly oblong, often falcate, flaccid or rigid leaflets (3) 5–40 mm. long, 1–4 (6) mm. wide; scapes erect or rarely ascending, 4.5–25 cm. long; racemes 6–18-flowered, usually narrow and becoming lax at full anthesis, 3–15 cm. long in fruit; calyx pilose, rarely with some dark hairs, 7–10 mm. long, the tube 5.5–8 mm., the teeth (1.5) 2–4 mm. long; corolla pink-purple, exceptionally white, the banner (13.5) 15–20 mm. long, 7–10 mm. wide; wings (12) 14–18.5 mm. long, the blades slightly dilated upward, 4–5.5 (6) mm. wide near apex; keel 12–16.5 mm. long; pod sessile, the erect body 8–15 mm. long, equalling or twice as long as the calyx, 3.5–5 mm. in diameter, passing into the nearly straight to strongly divaricate beak 3–7 mm. long, the valves stiffly coriaceous or woody, castaneous and at length blackening after dehiscence, thinly to densely strigose-pilose. *Type* collected by Bradbury, in 1811, "on the Missouri," more precisely[16] "on the bluffs from the Maha village to the Poncars"; "Louisiana," *Bradbury in 1811* (PH)!

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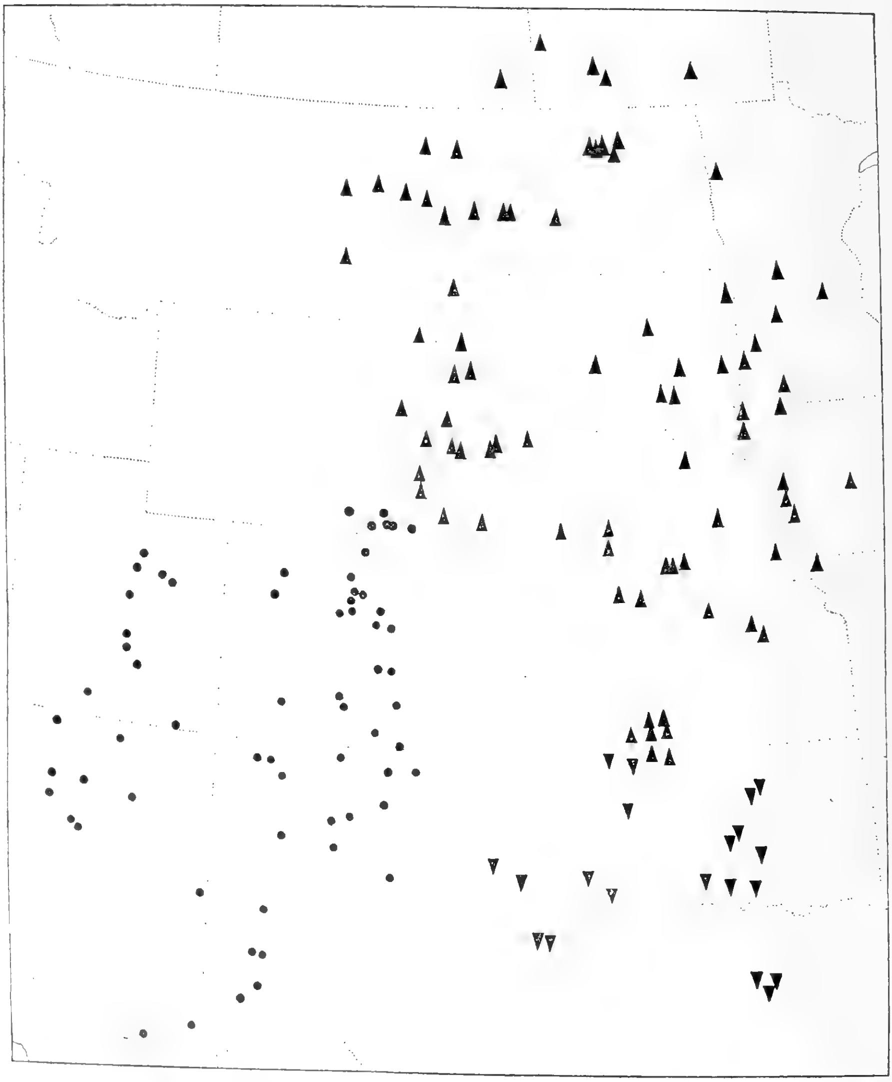
[16] Bradbury, Trav. Inter. N. Amer., Ed. 2, 346. 1819. As shown by Nelson (Univ. Wyo. Pub. Bot., 1:111), this locality is on the stretch of the Missouri River which now serves as boundary between Nebraska and South Dakota. Bradbury's map places the Maha or Mahar village about at the present Sioux City, and his Journal describes the encounter with the Poncars near the mouth of L'Eau qui Court River.

Distribution: Prairies, river-bluffs, and badlands, on clay, limestone, or loess, Manitoba and eastern Montana to western Missouri and Kansas, where it passes into var. *articulata.* Map 10.

Representative specimens: SASKATCHEWAN. Souris Plains, *Macoun 453* (US). MANITOBA. N. of Carberry, *Macoun & Heriott 70797* (CAS, GH, NY,



Map 10. Range of *Oxytropis Lambertii:* var. *Lambertii* ▲; var. *articulata* ▼; var. *Bigelovii* ●.

POM). MONTANA. Cedar Creek, 12 mi. above Glendive, Dawson County, *Ward in 1884* (US, type of *Aragallus rigens).* NORTH DAKOTA. Butte, Benson County, *Lunell, June 14, June 21 and July 2, 1908* (NY, US, WTC, isotypes of *Aragallus Aven-Nelsonii).* Leeds, Benson County, *Lunell in 1906* (NY, US). SOUTH DAKOTA. Hot Springs, Fall River County, *Rydberg 638* (NY). Fort Meade, Meade County, *Forwood 95* (US, type of *Aragallus formosus).* MINNESOTA. Acton, Meeker County, *W. D. Frost in 1892* (MINN, US, isotypes of *Aragallus involutus).* WYOMING. Hulett, Crook County, *M. Ownbey 664* (NY, WTC). NEBRASKA. Minden, Kearney County, *Hapeman in 1928* (NY, POM). Rush Creek, Sheridan County, *Rydberg 82c* (NY, type of *Aragallus angustatus).* IOWA. Bluffs at Missouri Valley, Harrison County, *Eggleston 15163* (GH, NY, US). KANSAS. Coldwater, Comanche County, *Rydberg & Imler 709* (NY). MISSOURI. Watson, Atchison County, *Bush 204* (GH, ND, NY, US, isotypes of *Aragallus falcatus* and of *O. Bushii).* OKLAHOMA. Aline, Alfalfa County, *Mark White in 1899* (NY).

Variation in var. *Lambertii* is especially marked in four directions: stature, density of vesture, texture and outline of the leaflets, and length of pod. The precisely typical form is of medium stature, silky-pilose with appressed hairs, and has submembranous leaflets with inconspicuously elevated margins. In similar modern collections the pod is commonly twice the length of the calyx, rarely shorter and with the beak only exserted. This is the form characteristic of virgin prairie, associated with grassland and rich soil. A common xerophytic modification, occurring on dunes, eroded clay bluffs or loess mounds here and there in the variety's range, has narrower, involute and sparingly pilose leaflets of thicker texture, stiffer scapes, and nearly always short pod. When tall, with open racemes, this corresponds with *Aragallus rigens;* when low and with short racemes, with *A. angustatus* and *A. Aven-Nelsonii.* In *O. Bushii* (or *A. falcatus,* based on part of the same collection) the foliage is of the xerophytic type but the pod is exserted. A phase common about the Black Hills and occasional elsewhere is densely and on occasion loosely pilose throughout, with thin and sometimes broader leaflets. A robust example of this state furnished the type of *Aragallus formosus,* a depauperate one that of *O. plattensis.* Greene described the flower of *A. formosus* as "cardinal red," but Forwood's field-label, preserved on the type-sheet, reads: "common on the plains, bright red, showy," and there is no reason to believe that the petals were anything more than the brilliant pink-purple common in the species. The type of *O. plattensis* is remarkable for its small corolla and densely villous stipules, and is perhaps the most isolated extreme yet known. However we have from the Badlands of North Dakota a plant *(Ripley & Barneby 8247,* CAS) nearly as villous, but with taller stems and larger flowers. This occurred in the field under two forms, one densely canescent and with short pod growing on bare clay ridges, the other greener and with longer pod found in the intervening gulches. No adequate criteria have been found by which these diverse aspects can be maintained above the rank of forma.

The segregates discussed so far have for the most part been ignored or reduced, or if listed they have been neither defined nor described. However the name "*O. dispar*" has gained a foothold in the literature of the plains states, and deserves fuller notice. The actual type of *Aragallus dispar,* and hence the name, does not belong to the *O. Lambertii* complex; it has basifixed pubescence and represents a race of *O. campestris,* treated above as var. *dispar.* Rydberg however, applied the name (Fl. Rocky Mts., 571) to a race of *O. Lambertii,* citing his own *Aragallus patens,* a true *Lambertii* segregate, as synonymous; and practically all Nelson's *O. dispar* of his 1926 paper (Univ. Wyo. Pub. Bot., 1: 114) belongs to *O. Lambertii* also. Thus "*O. dispar*" has come to stand for a species related to *O. Lambertii* but distinguished by strongly dimorphic leaves and short calyx-teeth. Unfortunately leaf-dimorphism is more nearly a character of the genus than of any species in it, and is almost universal in *O. Lambertii.* Even in the type of *O. Lambertii* the primary leaves are short (as little as 5 cm. long), with leaflets 4 mm. long and 1.5 mm. wide, while the secondary leaves reach a length of 13 cm., with leaflets up to 18 mm. long and 2.5 mm. in width. This is a normal or average state of dimorphism for the species, but in some phases the difference in shape and size of leaflets is accentuated. In this respect, much depends on the immediate environment of the individual plant. The primary leaves, formed in autumn and persisting over winter in the form of a terminal bud, expand in the cool temperatures of early spring, and tend to be short and pressed to the ground. Where a plant has seeded into dry or barren ground, the secondary leaves which accompany the scapes may be quite similar, though always longer. By contrast in a plant surrounded by rapidly developing vegetation, as is the case under prairie-conditions, the secondary foliage is more lush and drawn out, and the leaflets are longer. Short calyx-teeth, supposedly characteristic of "*O. dispar,*" are rather uncommon in var. *Lambertii,* but do occur occasionally far to the north of the range of var. *articulata,* of which they are nearly characteristic. But they are in no way correlated with strongly dimorphic leaves.

The early treatments of *O. Lambertii* call for some comment. In *Flora Boreali-Americana,* Hooker divided the species into vars. α and β, neither of which corresponds altogether with the modern concept. The var. β was based on collections obtained by Douglas and Drummond in Canada which represent a form intermediate between *O. viscida* and *O. campestris* var. *gracilis,* further discussed under the heading of *O. viscida.* To var. α Hooker referred several collections of *O. campestris* var. *johannensis,* and a figure, Botanical Magazine No. 2147. Torrey and Gray (Fl. N. Amer., 1: 339) did something to correct this treatment, excluding from their typical (var. α) *O. Lambertii* all of Hooker's which was then divided between a dubious var. δ for the Quebec plants and a new var. γ based on the Sims plate. This last depicts a somewhat large-flowered form of *O. Lambertii* and was modelled on a plant grown in Lambert's garden from seed collected by Nuttall on "woodless hills of the Missouri." Since we have not only specimens collected by Nuttall ("Louisiana," *Nuttall,* PH ex herb. Lambert.) but, more importantly, Pursh's testimony that he had seen *O. Lambertii* growing in England ("v. v. in hort. Lambert" ex char.), it can scarcely be doubted that the plate and therefore Torrey and Gray's var. γ are essentially typical. A further variety, *O. Lambertii* ϵ T. & G. has remained unidentified; cf. excluded species, inf.

Authentic material of *O. Hookeriana* Nutt. ex T. & G. is apparently lacking in American herbaria. At the writer's request Mr. N. Y. Sandwith obligingly sought out the type-specimen in the British Museum, and reported that he found a sheet bearing the characteristic star and legend in Nuttall's hand: "*O. Hookeri. O. Lambertii β* Hook. Platte Plains." The presence of dolabriform hairs, as found by Sandwith, definitely places *O. Hookeriana* as a form of *O. Lambertii.* The calyx-teeth are "3–4 mm." long, the extreme length attained in var. *Lambertii* but not unusual. The epithet *Hookeriana* is explained by Nuttall's apparent intention of renaming Hooker's *O. Lambertii β.* But this, as we have seen, is not related to *O. Lambertii* and is certainly not conspecific with Nuttall's plant.

The aptly named *O. Lambertii* var. *mixta* was described from a plant collected by Lycurgus Moyer at Montevideo, Minnesota, and on part of *A. Nelson 1320* from Wyoming. Topotypes collected at Montevideo (*Moyer in 1909,* NY) are var. *Lambertii,* and the actual type can scarcely belong elsewhere. The Wyoming plant represents var. *Bigelovii.*

18b. **Oxytropis Lambertii** Pursh var. **articulata** (Greene) Barneby

Oxytropis Lambertii Pursh var. *articulata* (Greene) Barneby, Leafl. West. Bot., 5:111. 1951. *Aragallus articulatus* Greene, Proc. Biol. Soc. Wash., 18:13. 1905.
Aragallus abbreviatus Greene, op. cit., 12. 1905.

Green but finely pilose throughout; leaflets (7) 9–19, narrowly linear to linear-oblong, 10–35 mm. long, 1–3.5 (5.5) mm. wide, commonly thick and rigid, rarely thinner and flaccid; calyx silky-pilose, the tube 6–8 mm., the triangular-subulate teeth 1.2–3 (very rarely 4) mm. long; corolla relatively large, the banner 18–25 mm. long; wings 15–25.5 mm. long, commonly much dilated upward; keel 14–19 mm. long; pod stiffly woody, the body ovoid to oblong-ovoid, commonly 7–10 mm. long and scarcely exserted, but sometimes up to 17 mm. long and nearly twice as long as the calyx, the stout beak commonly divergent and 3–5 mm. long, the valves densely silky-strigose, the partition as a rule not quite complete. *Type* collected by J. M. Bigelow, in 1853, "on the Canadian River, perhaps within the limits of Colorado," but according to the label, between Fort Smith and the Rio Grande, hence either Oklahoma or western Texas; *Bigelow in 1853* (US)!

Distribution: Prairies and bluffs, often on gypseous or calcareous soils, Oklahoma and western Texas. Map 10.

Representative specimens: OKLAHOMA. Fort Sill, Comanche County, *Mrs. Clemens 11683* (CAS, GH). Hennepin, Murray County, *Ripley & Barneby 7463* (CAS). TEXAS. Near Dallas, Dallas County, *J. Reverchon 603* (ND, type of *Aragallus abbreviatus), distrib. Curtis No. 603* (NY, isotype), *No. 4329a* (NY). Tarrant County, *Ruth 25* (GH, NY). Giles, Donley County, *Ripley & Barneby 7502* (CAS).

As here circumscribed, var. *articulata* is nearly as polymorphic as var. *Lambertii*, and the diverse materials referred to it are not distinguished by any single infallible character. Nearly all the plants seen from south of the Oklahoma state line are alike in their relatively large flowers and in the proportion of calyx-tube to teeth, the latter being for the most part absolutely, and with rare exceptions relatively much shorter than in var. *Lambertii.* The phase to which the type belongs is the extreme xerophyte, with narrow, rigid leaflets and shortly ovoid, scarcely exserted pod; and this is the common form throughout the range of the variety. Plants similar in aspect occur here and there northward to Montana, but these have the short calyx-tube and long teeth of var. *Lambertii,* and are interpreted as more trivial modifications due to arid habitat. Just as the latter simulate var. *articulata,* so we find plants from central Texas with exserted pod and more ample herbage which ape var. *Lambertii* in appearance, but are distinguished by their short calyx-teeth and extremely large petals. To this form, which is included in var. *articulata* as a minor variant, belongs the type of *Aragallus abbreviatus.*

The variety is a weak one, particularly since so many combinations of characters are found within it, and some specimens suggest direct intergradation with var. *Lambertii* or, in somewhat broad leaflets, with var. *Bigelovii.* The following average measurements of calyx and banner taken from twenty representative collections of var. *articulata* and as many of var. *Lambertii* disclose real differences which cannot be ignored when correlated with a natural and continuous area of dispersal:

	calyx-tube (mm.)	teeth (mm.)	proportion	banner (mm.)
var. *Lambertii*	6.25	2.14	1:2.94	16.95
var. *articulata*	7.59	1.47	1:5.16	21.39

The plant collected "in territorio Texano" by von Neuwied and mentioned by Bunge (Gen. Oxytr., 85) as probably of a species distinct from *O. Lambertii* must doubtless belong to var. *articulata.*

18c. **Oxytropis Lambertii** Pursh var. **Bigelovii** Gray

Oxytropis Lambertii Pursh var. *Bigelovii* Gray, Proc. Amer. Acad., 20:7. 1884. *Aragallus Bigelovii* (Gray) Greene, Pittonia, 3:212. 1897. *Astragalus Lambertii* var. *Bigelovii* (Gray) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1937.

Astragalus intermedius Jones, Proc. Calif. Acad. Sci., II, 5:656. 1895, pro parte, quoad char. fruct.

Aragallus Metcalfei Greene, Proc. Biol. Soc. Wash., 18:12. 1905.

Aragallus Knowltonii Greene, op. cit., 19. 1905.

Aragallus patens Rydb., Bull. Torr. Club, 34:421. 1907. *Oxytropis patens* (Rydb.) A. Nels., Univ. Wyo. Pub. Bot., 1:114. 1926.

Oxytropis bilocularis A. Nels., op. cit., 111. 1926.

Pilose throughout, the pubescence everywhere appressed, or the scapes, petioles and calyces bearing some loose hairs, the herbage silky-canescent or greenish; stipules permanently silky or at length glabrate dorsally and merely ciliate; leaves spreading or erect, (2.5) 5–17 (24) cm. long, with (3) 7–15 (19) ovate, elliptic, broadly lanceolate or very rarely (in some leaves) linear leaflets 7–20 (32) mm. long, (2.5) 3–8 mm. wide; scapes erect, (4) 7–25 (35) cm. long; racemes 8–28 (45) -flowered, commonly elongating and the axis (3) 5–16 cm. long in fruit; flowers usually spreading at a wide angle; calyx (6.5) 8–10 mm. long, the white-silky tube (4.5) 5–7 (7.5) mm., the subulate teeth (1.5) 2–4 mm. long; petals brilliant pink-purple, exceptionally white or polychrome (varying between white and purple in a colony); banner (15) 18–23 (25) mm. long, (6) 8–11 mm. wide; wings (13.5) 15–20 (22) mm. long, the emarginate blades obliquely dilated and (4) 5–7 (8) mm. wide near apex; keel (12) 13–16 (17) mm. long; pod sessile or shortly stipitate, erect or spreading at maturity, narrowly lance-acuminate in outline, the body 15–25 mm. long, 2.5–5 (6) mm. in diameter, tapering into a slender, commonly straight beak about 5 mm. long, the valves thinly coriaceous, scarcely rigid, strigose or strigulose, often glabrate at length, the partition usually complete, 0.8–1.9 mm. wide. *Type* collected by J. M. Bigelow, in 1853, "on the Canadian River, in Colorado?" actually in Guadalupe or San Miguel County, New Mexico[17]; Upper Canadian, *Bigelow in 1853* (GH, US)!

Distribution: Sandy plains, sagebrush mesas, mountainsides, rarely on sand-dunes, to the south commonly in yellow pine-forest, from southwestern Wyoming southward, mostly in the foothills of the Rocky Mountains on both slopes of the Divide to central New Mexico, west to the Wasatch, Utah, and the Mogollon system of central and southern Arizona. Map 10.

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[17] The Whipple Expedition entered New Mexico from the Texas Panhandle on September 30, 1853, at a point east or northeast of Tucumcari (cf. Standl., Cont. U. S. Nat. Herb., 13:148) and travelled due west to Albuquerque. On September 26, the date given on Bigelow's label, the company camped at Sheep Spring, a day's journey to the east of Anton Chico, a settlement on the Pecos River in northwestern Guadalupe County. The type of var. *Bigelovii* must have been encountered on or near the Canadian-Pecos divide.

Representative specimens: WYOMING. Head of Pole Creek, Albany County, *A. Nelson 1320* (CAS, NY, WTC). Fort Steele, Carbon County, *Tweedy 5633* (NY). UTAH. West Tavaputs Plateau, 20 mi. n. of Wellington, *Maguire 18529* (GH, NY). S. of Needle Rock, Monument Valley, *Holmgren 3232* (GH, NY, WTC, WTU). Soldier Summit, Wasatch County, *Jones 5600* (NY, POM, WTC). COLORADO. Plains and foothills near Boulder, Boulder County, *Tweedy 5164* (NY, type of *Aragallus patens).* Cuchara River below La Veta, Las Animas County, *Rydberg & Vreeland 5999* (NY). S. of Axial, Moffat County, *Ripley & Barneby 9161* (CAS). ARIZONA. Miller Peak, Huachuca Mts., Cochise County, *Goodding 2411* (GH, NY, POM, isotypes of *O. bilocularis).* Jhu's Pass, Chiricahua Mts., Cochise County, *Blumer 1950* (GH, NY, partly white-flowered). San Francisco Mts., Coconino County, *Knowlton 44* (US, type of *Aragallus Knowltonii).* NEW MEXICO. Mimbres to Santa Rita, *Wright 1006 in 1851* (GH, NY). Sawyer's Peak, Grant County, *Metcalfe 1079* (US, type of *O. Metcalfei,* CAS, GH, POM). 19 mi. w. of Santa Fe, Santa Fe County, *A. & G. Heller 3621* (NY, OB, POM, US, WTC).

The var. *Bigelovii* is nearly as variable as var. *Lambertii,* presenting a series of fluctuating forms. The northern and southern extremes, which approximate to *O. patens* and *O. bilocularis,* are fully intergradient. Most of the material from southern Wyoming and adjacent Colorado is characterized by short, strongly dimorphic, spreading leaves, and the sessile pod may be either erect or spreading, the latter condition being supposedly characteristic of *O. patens.* These are plants flowering in spring and early summer on high, cold plateaux and small areas of elevated prairie on the flanks of the Rocky Mountains, and the habit is no doubt an expression of the environment and season. Further south an exactly similar form occurs sporadically in exposed situations (cf. *Jones 4050,* from Flagstaff, Ariz., POM). In the mountains of New Mexico and Arizona the prevailing form is more robust, with erect and ample, less strongly dimorphic leaves, and longer racemes *(Aragallus Knowltonii, A. Metcalfei,* and *O. bilocularis).* This flowers in the period of summer and autumn rains, and the legume is commonly erect and shortly stipitate. But individuals as robust occur right through the variety's range, as Nelson inferred in the range attributed to *O. bilocularis,* and the pod may be either stipitate or strictly sessile, spreading or erect, in plants otherwise alike. We have an example of var. *Bigelovii* from Gunnison, Colorado *(Ripley & Barneby 7159)* which in its short, semi-spreading leaves and divaricate, stipitate pod neatly combines the salient features of *O. bilocularis* and *A. patens.*

Nelson's attempt to segregate from *O. Lambertii* a species, *O. bilocularis,* on the basis of a complete septum in the pod, was ill considered. The pod of *O. Lambertii* as a whole is bilocular in the fresh state, or so nearly so that the difference is hardly of practical importance. In the mature or artificially dried fruit some differences do appear. When the valves are fleshy, as is the case in var. *Lambertii* and var. *articulata,* the inner wall commonly shrinks in ripening, thereby leaving a gap between the dorsal suture and the free edges of the partition, when the pod may appear semibilocular. Structurally, however, this is not different from the thinner-walled pod of var. *Bigelovii,* where the shrinkage is less or almost none, and contact between the partition and the suture is maintained until dehiscence. Moreover the degree of shrinkage even in the fleshy pod is uncertain and variable, and perfectly typical var. *Lambertii* from Kansas (e. g. *Rydberg & Imler 702,* NY), from far outside the range attributed by Nelson to *O. bilocularis,* sometimes has a mature, fully bilocular legume.

Bigelow's plant represents an uncommon and marginal phase of var. *Bigelovii* as here circumscribed. The leaflets are linear-lanceolate and five to ten times longer than wide, in fact of the type commonly associated with var. *Lambertii.* But the pod is thinly coriaceous and stipitate, as found only in the Cordilleran populations of the species. Several collections from San Miguel, Colfax, and Mora counties in New Mexico resemble it in leaflet-outline, and it seems to belong to a minor variant prevalent in this region and perhaps intergradient toward var. *Lambertii.*

The variety has passed in floras under many names. Wooton and Standley (Cont. U. S. Nat. Herb., 19: 371) referred most of the taller New Mexican material to *O. pinetorum (O. sericea* var. *sericea).* Rydberg (Fl. Rocky Mts., 521), misled by the superficially similar dimorphism of the leaves, reduced his *A. patens,* here included in var. *Bigelovii,* to *A. dispar (O. campestris* var. *dispar).* The more silvery states have been called *O. sericea* (but not of Nuttall), until Kearney and Peebles (Fl. Pl. Ariz., 490) pointed out the trivial nature of vesture as a criterion in *O. Lambertii.*

19. **Oxytropis Maydelliana** Trautv.

Oxytropis Maydelliana Trautv., Act. Hort. Petrop., 6:16. 1879.

Oxytropis campestris ξ melanocephala Hook., Fl. Bor.-Amer., 1:147. 1834.

Oxytropis campestris ε glabrata Hook., loc. cit., 1834. *O. glabrata* A. Nels., Univ. Wyo. Pub. Bot., 1:117. 1926.

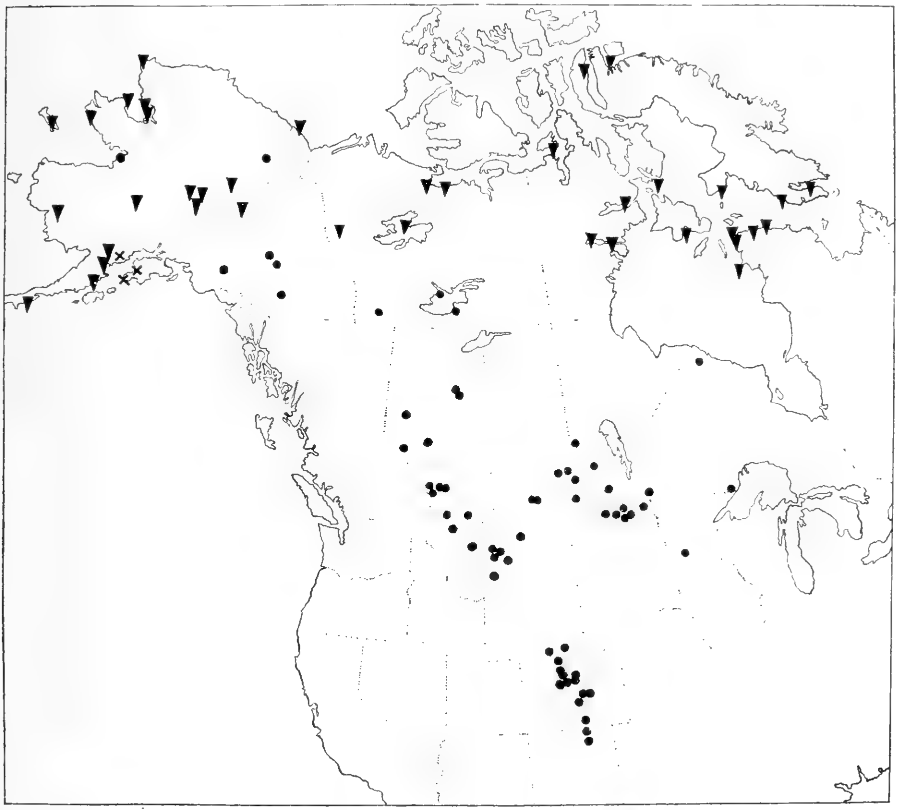
Cespitose, from a stout pluricipital taproot, the crowns clothed below with a thatch of marcescent stipules and leaf-bases; stipules lanceolate, (10) 14–21 mm. long, at first yellowish-brown but early becoming purplish-chestnut color (or at length nearly black), stiff and chartaceous, glabrous or nearly so dorsally, the deltoid to lance-caudate free blades 4–11 mm. long, hispid-ciliate with yellowish hairs often mixed with a few clavate processes; leaves unequal in length but not strongly dimorphic, 4–14 cm. long, the petioles either thinly appressed-pilose or more or less hirsute, particularly at base; leaflets (9) 11–17, ovate to lanceolate, elliptic or oblong, obtuse or acute, green and somewhat fleshy (becoming rugulose when dry), 4–13 mm. long, sparingly pilose, especially near the margins above and on the midrib beneath, occasionally nearly glabrous; scapes erect, thinly villous-hirsute throughout or only below the inflorescence, 3.5–15 cm. long; racemes subcapitate or oblong, densely 5–10-flowered, the flowers and pods erect, the axis becoming 1–3 cm. long in fruit; bracts lanceolate, mostly acute, 4–10 mm. long, pilose dorsally and ciliate, commonly with fuscous hairs; calyx shaggy-pilose with all dark or mixed dark and pale hairs, 5–6.5 mm. long, the tube 4–5 mm., the subulate-deltoid teeth 1–2 mm. long, separated by rather wide and obtuse sinuses; petals pale yellow, immaculate; banner oblanceolate, or the blade obovate, the whole 14–16.5 mm. long, 5–7 mm. wide; wings 12–14 mm. long, the oblong or oblong-triangular blades 7–9.5 mm. long, 2.5–3.5 mm. wide near the obliquely truncate to deeply emarginate apex; keel 11–12.5 mm. long; pod ovoid or ellipsoid, tumid, the body 10–14 mm. long, 4–5 mm. in diameter, abruptly or gradually contracted into a narrow, straight, or divaricate beak 4–6 mm. long, sulcate ventrally, the valves membrano-chartaceous, pilosulous with dark and pale hairs, the partition about 1 mm. deep, apparently never complete; seeds brown, nearly smooth, 1.6–1.8 mm. in diameter. *Type* collected by Baron G. von Maydell, in 1869, ". . . in tractu fluvium Anadyr inter et latus meridionale montium jugi a fluvio hoc septentrionem versus siti . . .," i. e. eastern Siberia.

Distribution: Arctic and subarctic shores, descending to latitude 62°, Ungava Peninsula, Quebec, to Baffin Island, west to coastal and interior Alaska, Chukches Peninsula, and Kamtchatka. Map 11.

Representative American specimens: ALASKA. Point Hope, *Mason in 1931* (CAS, GH). Polychrome Pass, McKinley Park, *A. & R. Nelson 3816* (GH, NY, WTC, WTU). Katmai region, Alaska Peninsula, *Hagelbarger 78* (US). MACKENZIE. Coppermine, *Dutilly in 1934* (GH). Great Bear Lake, *Preble 287* (US). FRANKLIN. Gjöa Harbor, King William I., *Lindstrom in 1904* (NY). Lake Harbor, Baffin I., *Polunin 2273* (GH), *2287* (NY). KEEWATIN. Wager Inlet, Hudson Bay, *Macoun 79103* (GH, NY). QUEBEC. Erick Cove, Hudson Strait, *Low 22991* (GH, NY, US).

Oxytropis Maydelliana, distinctive by reason of its stiff, glabrous, purple-brown stipules, its green, somewhat fleshy herbage, and yellow flowers, is apparently the commonest species of *Oxytropis* in high latitudes and the most widespread, extending from Hudson Strait and Baffin to Alaska and northeastern Siberia. The forty-odd collections seen are remarkably uniform in appearance and detail. The species has been amply and admirably treated by Fernald (Rhodora, 30:142), Hultén (Fl. Kamtch., 3:106, fig. 12, a, b, c.) and Polunin (Bot. Canad. E. Arct., 291), to whose accounts the reader is referred for fuller information.

Oxytropis campestris ε glabrata, to which Hooker ascribed the character "foliis glabriusculis subsucculentis" and a northern but imprecise station (with var. *melanocephala:* "Bear Lake to the Arctic Shores and Islands"), is referred here on the basis of a specimen in the Gray Herbarium labelled "*O. campestris* ε *glabrata,* from Dr. H[ooker], 1832, Amer. Bor.," and presumably authentic for the variety. The point should however be checked against the Hooker Herbarium, since Hultén (Fl. Alaska & Yukon, 1098) states that the authentic var. *glabrata* seen by him was a form of *O. gracilis;* and it was in that sense that Rydberg (Fl. Prair. & Pl., 485) used the term *O. glabrata.* The plant that Nelson had in mind *(Gorman 1365,* WYO) when he transferred var. *glabrata* to the specific category is, however, *O. Maydelliana.* It seems probable that the unnamed variety of *O. campestris* described by Chamisso (Linnaea, 6:546, 1831) from St. Lawrence Strait and Cape Espenberg in Alaska is to be identified with *O. Maydelliana* also. Chamisso drew attention to the persistent stipules being "fuscis carboneis," which applies well to the species; but other details are less convincing.



Map 11. American range of *Oxytropis Maydelliana* ▼; range of *O. splendens* (Alaskan stations after Hultén) ●; and of *O. campestris* var. *varians*, the "*alaskana*" form **X**.

20. **Oxytropis arctica** R. Br.

Oxytropis arctica R. Br., Parry's First Voy., Append., 9:278 (Chlor. Melvill., 209, in R. Br., Collected Works). 1824. *Astragalus arcticus* (R. Br.) Spreng., Syst., 4^2:288. 1827. *Oxytropis uralensis δ arctica* (R. Br.) Ledeb., Fl. Ross., 1:594. 1842. *Spiesia arctica* (R. Br.) O. Kze., Rev. Gen., 205. 1891. *Aragallus arcticus* (R. Br.) Greene, Pittonia, 3:211. 1897.

Oxytropis arctica α subumbellata Hook., Parry's Second Voy., Append., 4:396. 1825.

Oxytropis Roaldi Ostenf., Vasc. Pl. Arct. N. Amer. Gjöa Exped., 54, Pl. 3, fig. 16. 1910.

Oxytropis coronaminis Fern., Rhodora, 30:151, Pl. 175. 1928. *Astragalus coronaminis* (Fern.) Tidestr., Proc. Biol. Soc. Wash., 50:19. 1947.

Cespitose, from a pluricipital taproot, the divisions of the caudex clothed in a thatch of marcescent petioles and stipules; herbage densely villous-pilose, the leaflets sometimes thinly so and greenish, the vesture commonly fulvescent in age; stipules 6–12 mm. long, pale and fragile, at first connate opposite the petiole, densely pilose throughout or the tips rarely glabrate in age, the deltoid to deltoid-acuminate free blades 3–6 mm. long, their margins bristly-ciliate and beset with clavate processes; leaves 1.5–9 cm. long, the petioles loosely pilose; leaflets 11–19 (21), ovate to narrowly oblong or elliptic, 2–11 mm. long, all usually solitary and opposite, but a few sometimes geminate in unequal pairs; scapes ascending or erect, 1.5–13 cm. long, villous-pilose or pilosulous, at least below the inflorescence, the hairs there commonly fuscous; racemes subcapitately 2–10-flowered, becoming looser, the axis up to 12 mm. long in fruit; bracts linear-lanceolate, 3–9 mm. long, shaggy-pilose dorsally, the hairs mostly black; pedicels becoming up to 4 mm. long in fruit; calyx shaggy-pilose with dark or mixed dark and light hairs, the cylindro-campanulate tube 5–9 mm., the deltoid to linear-lanceolate teeth 1–5 (6) mm. long; petals purple; banner obovate, sometimes very broadly so, 15–21 ("27") mm. long, 6.5–13 mm. wide; wings 12.5–17 mm. long, the blades 9–12 mm. long, 4.5–6 mm. wide near apex; keel 11–15 mm. long; pod sessile or nearly so, the body oblong-ellipsoid, 10–15 mm. long, 5–7 mm. in diameter, obtuse at base, contracted upward into a nearly straight, acuminate beak 5–10 mm. long, slightly obcompressed, deeply sulcate ventrally and obscurely so dorsally, the valves thinly chartaceous, pilosulous with mixed black and white hairs, the ventral suture produced inward as a partition about 1 mm. wide, the dorsal somewhat prominent within but not septiferous; seeds pale brown, 1.5–1.8 mm. in diameter. *Type* collected on Admiral Parry's First Voyage, on Melville Island.

Distribution: Arctic shores, inland in Alaska only, from the south shore of Rae Isthmus at about 87° W., westward through coastal Mackenzie and the islands of the Polar Sea to the upper Yukon and Seward Peninsula, Alaska; reported from Siberia. Map 12.

Representative American specimens: ALASKA. Teller Reindeer Station, Port Clarence, *Walpole 1522* (US). Sheenjek Valley, *Mertie in 1926* (US). YUKON. Herschell I., *Lindstrom in 1906* (NY, isotype of *O. Roaldi).* MACKENZIE. Arctic sea-coast, *Richardson* (GH, type of *O. coronaminis* (GH). Epworth Harbor, Coronation Gulf, *Cox & O'Neill 395* (NY). Kent Peninsula, *Hoare 119027a* (GH, NY). FRANKLIN. Melville I., *Sabine* (GH). Winter Harbor, Melville I., *MacMillan 77294* (GH, NY). Repulse Bay, *C. F. Hall in 1869* (US).

Oxytropis arctica is apparently the only purple-flowered eglandular species of the *O. campestris* type native to the American segment of the Arctic Circle. The forms of *O. viscida* (var. *hudsonica* and var. *subsucculenta)* from the same range, even when their characteristic viscidity becomes obscure in drying, are distinguished by their somewhat succulent leaflets, dorsally glabrous bracts, and nearly always glabrescent stipules. The densely pilose *O. arctica,* with its fragile, permanently pilose stipules and shaggy bracts, is quite variable in stature, length of calyx-teeth and amplitude of the petals. Porsild (Sargentia, 4: 51, 1943) has pointed out that *O. coronaminis* and *O. arctica* are conspecific, and doubtless they are correctly interpreted as large- and small-flowered phases of one species. When Fernald described *O. coronaminis* he was evidently not clear as to the true identity of *O. arctica,* for he defined it as having 11–17 leaflets, black-villous bracts, and vexillum 4–7 mm. broad, yet figured a plant (Rhodora, 30, Pl. 172, upper fig.) with 21–23 leaflets and glabrous bracts, and cited a specimen from Melville Island *(Sabine,* GH) with banner at least 8 mm. broad. The plant photographed is a specimen of *O. viscida* var. *hudsonica;* that cited represents a reduced state of *O. arctica.* Simultaneously Fernald identified the MacMillan gathering from Melville Island, which closely resembles Sabine's plant, as "depauperate" *O. coronaminis.* In his second revision (1884) Gray placed both the little Sabine plant and Richardson's more robust collection from coastal Mackenzie in *O. arctica,* a disposition which is confirmed by study of additional material and by Porsild's judgment already mentioned.

The reduction of *O. Roaldi* is more difficult, though seemingly inevitable. It was recommended by Porsild, and effected by Hultén (Fl. Alaska & Yukon, 1105, map 834. 1947) in the sense that he considered *O. coronaminis* a synonym of *O. Roaldi.* In contrast to the loosely pilose *O. arctica-coronaminis,* with racemes of 2–5 large flowers (banner 8–17 mm. wide) and calyx-teeth 2–6 mm. long, the plants of Herschell Island, i. e. *O. Roaldi* in the strictly typical aspect, have subappressed-silky herbage, 7–9-flowered racemes of smaller flowers (banner 6–7 mm. wide), and calyx-teeth 1–1.5 mm. long. Fernald brought out all these points when establishing *O. coronaminis,* yet at the same time identified as his new species a collection from Coronation Gulf, *Cox & O'Neill 395.* The part of this gathering seen by the writer has a 5-flowered raceme, calyx-teeth only 1.5 mm. long, banner less than 1 cm. broad, and is therefore quite at variance with *O. coronaminis* as described by Fernald, and closely resembles isotypes and topotypes of *O. Roaldi.* Holm's figure of *O. Roaldi* (Rep. Canad. Arct. Exped., 5: 17A, pl. 8, fig. 2. 1921) which Fernald thought to be modelled on specimens of *O. coronaminis* with error in flower-number, seems to be an accurate delineation of *Cox & O'Neill 395*. Obviously then *O. Roaldi* and *O. arctica* both occur on Coronation Gulf, a suspicious circumstance in view of their close essential similarity. It might be thought that *O. Roaldi* exists as a more westerly ranging race, with at least tendencies toward smaller and more numerous flowers. But plants from the easternmost known station on Rae Isthmus have about 6 flowers of medium size (banner about 9 mm. wide), whereas those from Port Clarence on Behring Strait have subumbellate, 3–4-flowered racemes of broad showy flowers supposedly unique to *O. coronaminis.* At least until fuller data becomes available it is best to consider *O. arctica, O. coronaminis* and *O. Roaldi* as minor variants of a variable species.

It has been suggested by Polunin (Bot. Canad. E. Arct., 290. 1940, sub *O. terrae-novae)* that the name *O. artica* should be discarded, owing to the difficulty in determining which arctic *Oxytropis* Robert Brown had in mind. The detailed description, however, applies to the species here treated and to none other of the region. Moreover, *O. arctica* is still the only species of the genus positively known by modern collections from Melville Island, for, as Polunin himself has pointed out, specimens of *O. Maydelliana* and *O. arctobia (O. nigrescens* var. *uniflora)* so labelled were actually collected on Parry's Second Voyage, which did not reach the Polar Sea. Brown did have both *O. arctica* and *O. nigrescens* var. *uniflora,* and clearly distinguished the latter in the addenda to Chloris Melvilleana as "varietas notabilis . . . scapo saepe unifloro . . ." Since *O. arctica* and the var. *uniflora* are the only densely silky, purple-flowered species of *Oxytropis* in Arctic America, and since Brown explicitly distinguished them, the identity of *O. arctica* seems firmly established.

No Asiatic material of the species has been available, so that it is impossible to confirm the identity of *O. uralensis* var. *arctica* of Ledebour, or its reported occurrence on the lower Yenisei and Taimyr Peninsula, as quoted by Hultén (op. cit., 1106). Hultén states however that corresponding specimens "agree completely with large-flowered Alaskan *O. Roaldi.*"

The collection from Port Clarence, Alaska, cited above *(O. sewardensis* Wight ex Hult., op. cit., 1105, nomen) is remarkable in that the larger individual plants bear some leaves with a few paired leaflets, thereby recalling *O. Belli* of the eastern Arctic. It is a matter of conjecture whether the *O. Belli* reported by Schischkin (Fl. U. R. S. S., 13: 196. 1948) from Wrangel Island, not so very far to the northwest, may not refer to a similar form of *O. arctica.*

21. **Oxytropis Belli** (Britt.) Palib.

Oxytropis Belli (Britt.) Palib., Bull. Soc. Bot. Genève, II, 2:19. 1910. "*Spiesia Oxytropis Belli*" Britt. ap. Macoun, Canad. Rec. Sci., 6:148. 1894. *Aragallus Belli* (Britt.) Greene, Pittonia, 3:212. 1897. *Astragalus Belli* (Britt.) Tidestr., Proc. Biol. Soc. Wash., 50:18. 1937.

Cespitose from a pluricipital taproot, villous-pilose with fine, mostly tortuous hairs which become yellow when dry, the herbage canescent or greenish; stipules membranous, fragile, 10–20 mm. long, pilose dorsally, the deltoid-acuminate to narrowly acuminate free blades 3–10 mm. long, often glabrate at length, their margins ciliate with long pilose bristles and a few clavate processes; leaves 4–13 (17) cm. long; leaflets disposed in 7–10 fascicles of 3–4 together, the lowest on the rachis sometimes merely opposite or scattered, all ovate, oblong-ovate or lanceolate, obtuse or acute, 3–9 mm. long, villous-pilose on both faces, rarely glabrescent above; scapes about equalling the leaves, erect, densely villous-pilose with pale and (especially below the inflorescence) admixed fuscous hairs; racemes (2) 4–8 (10)-flowered, subcapitate at anthesis, the axis becoming 1–2 (4) cm. long in fruit; bracts narrowly lanceolate, 5–9 mm. long, densely shaggy-pilose dorsally, mostly with dark hairs; pedicels 1–1.5 mm long; calyx deeply campanulate, 9–10 mm. long, densely shaggy-pilose (dark hairs predominating), the tube 6–7.5 mm., the teeth 2.5–3 mm. long; corolla "pinkish-violet"; banner 18–21 mm. long, obovate-oblanceolate, 6–8 mm. wide; wings about 15 mm. long, their blades about 9 mm. long, somewhat dilated upward, 4–6 mm. wide near the oblique, emarginate apex; keel 13–14 mm. long, the straight or slightly declined appendage less than 1 mm. long; pod long-persistent on the axis, erect, sessile, oblong-ellipsoid, 12–20 mm. long, 4.5–7 mm. in diameter, slightly obcompressed and sulcate along both sutures, abruptly contracted into a slender straight or somewhat divaricate beak 3–5 mm. long, the valves chartaceous, densely short-villous with fuscous and occasionally some longer, pale hairs, the partition 1.5–2.5 mm. wide, extending across the cavity to the impressed and sometimes vestigially septiferous dorsal suture; seeds brown, 1.8–2 mm. in diameter. *Type* collected by R. Bell, in 1884, on Digges Island; *Bell, 15 September 1884* (NY, fragments, isotype; US mixed with *O. Maydelliana)!*

Distribution: Rocky or turfy shores of bays and islands about northern Hudson Bay; reported from Wrangel Island, Siberia[18]. Map 12.

Representative specimens: KEEWATIN. Ranken Inlet, *Macoun 79106* (GH, NY, OB). Fullerton, Hudson Bay, *Macoun 79105* (GH, NY). Chesterfield Inlet, *Burwash 119028* (GH, NY).

Oxytropis Belli is distinguished from our other species by the combination of pseudo-verticillate leaflets and relatively large violet flowers in short

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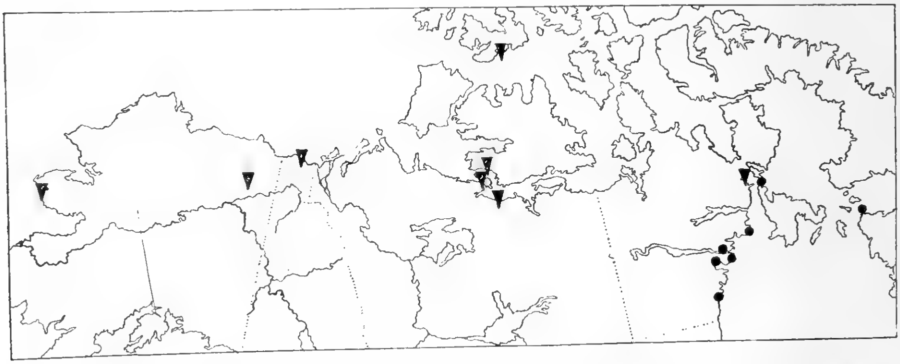
[18] Cf. discussion of the preceding species, *O. arctica*.

racemes. In the fragile stipules and quality of the vesture, as well as in the corolla and legume, it resembles *O. arctica,* and the two species seem more closely related to each other than to any other American species.



Map 12. Ranges of *Oxytropis arctica* (in America) ▼; and of *O. Belli* ●.

The history of *O. Belli* has been admirably set forth by Fernald (Rhodora, 30: 150. 1928), to whose account Polunin (Bot. Canad. E. Arct., 295. 1940) and Porsild (Sargentia, 4: 52. 1943) have added valuable data from field-experience.

22. **Oxytropis splendens** Dougl.

Oxytropis splendens Dougl. ex Hook., Fl. Bor.-Amer., 1:147. 1834. *Spiesia splendens* (Dougl.) O. Kze., Rev. Gen., 207. 1891. *Aragallus splendens* (Dougl.) Greene, Pittonia, 3:211. 1897. *Astragalus splendens* (Dougl.) Tidestr., Proc. Biol. Soc. Wash., 50:18. 1937.

Oxytropis splendens α *vestita* Hook., Fl. Bor.-Amer., 1:148. 1834.

Oxytropis splendens β *Richardsonii* Hook., loc. cit., 1834. *O. oxyphylla* sensu Richards., Bot. Append. Franklin's Journ., 745 (in reprint, p. 28). 1823; non DC. *Aragallus Richardsonii* (Hook.) Greene, Pittonia, 4:69. 1899. *Oxytropis Richardsonii* (Hook.) K. Schum., Just's Jahresb., 27^{1}:496. 1901; Woot. & Standl., Cont. U. S. Nat. Herb., 19:370. 1915, as "comb. nov." *Astragalus splendens* var. *Richardsonii* (Hook.) Tidestr., Proc. Biol. Soc. Wash., 50:18. 1937.

Aragallus caudatus Greene, Pittonia, 4:69. 1899. *Oxytropis caudata* (Greene) K. Schum., Just's Jahresb., 27^{1}:496. 1901, as "*caudatus.*"

Oxytropis splendens fma. *Nelsonii* Gand., Bull. Soc. Bot. France, 48:xvii. 1901.

Oxytropis splendens fma. *strigosa* Gand., loc. cit., 1901.

Aragallus galioides Greene, Proc. Biol. Soc. Wash., 18:16. 1905.

Cespitose from a pluricipital taproot, copiously silky-villous throughout, the vesture sometimes appressed or rather thin on the leaflets, but always villous-hirsute about the bases of the petioles and scapes, the hairs fulvescent in age; stipules membranous, fragile, silky-pilose dorsally, the deltoid to deltoid-acuminate free blades 5–12 mm. long; leaves (5) 7–26 cm. long, sometimes strikingly dimorphic, the primary ones then with shorter and broader leaflets, the petioles (1) 2–9 cm. long; leaflets numerous, 2–4 of unequal length disposed at a point in 7–15 fascicles diminishing upward along the rachis, a few sometimes solitary, opposite or scattered, all elliptic, narrowly to broadly lanceolate or oblong, acute or acutish (very rarely obtuse), 3–20 mm. long, canescent on both faces or rarely greenish above; scapes erect, 10–36 cm. long, usually well surpassing the leaves; racemes ovoid to narrowly oblong, (9) 12–35-flowered, dense at first anthesis (or with a few remote, scattered flowers below), the axis elongating and (3) 4–16 cm. long in fruit; bracts linear or lanceolate, 5–17 (23) mm. long, densely silky-pilose dorsally and ciliate; calyx silky-villous with pale, or some darker hairs, 8–10 mm. long, the tube 5–6.5 mm., the teeth (1.5) 2–4 mm. long; corolla rose-color or carmine, drying violet; banner oblanceolate to narrowly obovate, 12.5–16 mm. long, 4.5–6 mm. wide, obscurely emarginate; wings 10.5–12 mm. long, the blades oblong, 6.5–8 mm. long, scarcely dilated upward, 2.5–3 mm. wide near the truncate-emarginate apex; keel 10–11.5 mm. long, the appendage minute or up to 1 mm. long, straight or curved; pod minutely stipitate, ovoid-ellipsoid or oblong, 10–17 mm. long, 3–5 mm. in diameter, the body sulcate on both sutures and somewhat obcompressed, passing gradually or abruptly into an erect or somewhat divaricate beak 3–4 mm. long, the valves thinly chartaceous, densely subappressed-pilose, the partition 0.7–1.5 mm. wide, the dorsal suture sometimes raised within and bearing a vestigial septum; seeds numerous, dull, chestnut or umber, 1.5–1.8 long. *Type* collected by David Douglas, "on the limestone rocks of the Red River, and south toward Pembina," presumably southern Manitoba.

Distribution: Meadows, river-banks, prairies and mountain parks, in rich and often moist soils, Alaska to northern Ontario, Minnesota, and along the Rocky Mountains, chiefly on the Atlantic slope, to northern New Mexico. Map. 11.

Representative specimens: Without locality, *Richardson* (NY ex herb. Hook.; GH, as "*O oxyphylla* of Richardson," isotypes of *O. splendens β Richardsonii*). Yukon. Fort Selkirk, *Gorman 1057* (POM, US). Alberta. Peace Point, *Raup 2733* (NY, UC, US). Bow River near Banff, *McCalla in 1899* (US, type of *Aragallus galioides*), *No. 2129* (NY, WTU). Saskatchewan. Spy Hill, *Macoun & Herriott 70802* (CAS, GH, ND, NY, POM). Moose Jaw, *Macoun 13957* (ND, type of *Aragallus caudatus*). Manitoba. Red Deer Lakes, *J. Macoun 454* (NY). Ontario. Sleeping Giant, Thunder Bay Distr., *Taylor, Losee & Bannan 2194* (GH). Montana. Castle City, Meagher County, *C. L. Hitchcock 15918* (RB, WTC, WTU). North Dakota.

Butte, Benson County, *Lunell in 1907* (NY). Minnesota. Chippewa River, *Dr. Suckley* (GH). Wyoming. Pole Creek, Albany County, *A. Nelson 1391* (NY, OB, US). Colorado. Hot Sulphur Springs, Grand County, *Shear & Bessey 4314* (NY, US). Twin Lakes, Lake County, *Clokey 3592* (CAS, NY, POM, WTC). New Mexico. Winsor's Ranch, San Miguel County, *Standley 4064* (NY).

Oxytropis splendens, well marked by its cylindric or at first clavate spike of smallish purple flowers, numerous whorled leaflets and fine silky-villous vesture, is rather a stable species. Variation is conspicuous only in length of the bracts and in density of the pubescence, and the segregates which have been proposed have from early times been based on these characters. Hooker recognized from the first a typical α *vestita,* "valde hirsuto-sericea, bracteis hirsutissimis calyce multo longioribus," described from Douglas's Red River plants, and a β *Richardsonii,* "minus hirsuta, bracteis vix longitudine calycis," collected between the Saskatchewan River and the Rocky Mountains. It has long been apparent that these criteria of bracts and pubescence do not always coincide, witness plants from Severn River, Ontario *(Macoun in 1886,* NY), glabrescent and bracteose, and much material from the Rocky Mountains with the opposite combination; so that var. *Richardsonii* can at best be distinguished by but one, and that a fluctuating and minor character. Greene (Pittonia, 4: 69) declared that var. *Richardsonii* differed also from *O. splendens* in "much smaller flowers," but no correlation between flower-size and length of bracts can be made out in material which has accumulated since. It must be admitted, however, that the long-bracted form is more frequent on the northern plains, whereas most cordilleran plants are short-bracted. But exceptions (cf. *Tweedy 5630,* from Colorado; *A. Nelson 1391* from Wyoming: as robust and bracteose as anything from Manitoba) and intermediate states are numerous, and var. *Richardsonii* is probably no more than an occasional response to environment with little claim to systematic recognition.

The species proposed by Greene, each from a single collection, are likewise inconsiderable modifications. The type of *A. caudatus* represents the extreme bracteose condition (bracts up to 23 mm. long, far surpassing the calyx) and seems to correspond exactly with the original *O. splendens* of Douglas. It was reduced even by Rydberg to the species. *Aragallus galioides* was maintained by Rydberg as having narrower and less silky leaflets, but the type, although rather slender and green, perhaps from shady habitat, is in no other way remarkable. Gandoger's formae are equally unimportant.

In his treatment of *O. splendens,* Bunge mentioned an "*O. micans,*" said to differ only in "carinae mucro paullo longior" (Gen. Oxytr., 137. 1874). No further reference to this name has been traced, and it was perhaps found on an herbarium sheet; at least it seems never to have been published.

INTRODUCED SPECIES

Oxytropis riparia Litv.

Oxytropis riparia Litv., "Sched. Herb. Fl. Ross., 6:98. 1908"; Vassil. & B. Fedtsch. in Fl. U.R.S.S., 13:42. 1948.

Astragalus Rubyi Green & Morris, Jour Amer. Soc. Agron., 27:546, 549, figs. 1, 2. 1935, *nomen provis.*

Coarse, diffuse, strongly caulescent perennial herb, green but minutely strigose; stipules foliaceous, 5–10 mm. long, united through about half their length opposite the petiole; leaves subsessile, with 11–17 broadly oblanceolate, acute or acutish leaflets 1–3 cm. long; peduncles far surpassing the leaves; racemes lax, subsecund, the axis becoming 3–20 cm. long in fruit; flowers small, purplish, the banner about 6 mm. long; calyx white-strigose, the tube 2–2.5 mm., the teeth about 1.5 mm. long; pod pendulous, stipitate, the stipe 1–2.5 mm., the narrowly oblong body 1.5–2 cm. long, 4–5 mm. in diameter, sulcate ventrally, the valves papery, strigulose, not inflexed.

Distribution: Native to Russian Turkestan (Kara-Kum, Turkmenistan; Amu-Darya River); introduced and cultivated in southwestern Montana.

In 1930 or thereabouts a strange leguminous plant appeared on ranches near Waterloo and Twin Bridges, in the valleys of the Ruby and Jefferson rivers in Madison County, Montana. According to the botanists of the State College, Bozeman, it formed lush growths on alkaline bottom-lands and provided palatable forage similar to alfalfa. Analysis showed a relatively high phosphorus content for a crop grown on alkaline soil, and suggested that it might become useful on otherwise barren lands.

Only two specimens purporting to represent *Astragalus Rubyi* have been seen: "secured from Mr. Morris, Bozeman," distrib. *A. & R. Nelson 3184* (UC); Fargo, Montana, cultivated, *O. A. Stevens 291* (UC), and no authentic Russian *O. riparia* has been available for comparison. The present identification is based therefore on the ample description in the Flora of the Soviet Union[19], which seems to fit our plant down to the last detail.

Oxytropis riparia, placed in sect. *Mesogaea* by the Russian botanists, is related to *O. deflexa,* which it resembles in its small flowers and pendulous, stipitate pods. It is a much coarser plant, however, with larger, fewer leaflets, and may be distinguished at once by its ample herbaceous stipules which are connate through nearly half their length opposite the petiole.

EXCLUDED AND IMPERFECTLY KNOWN SPECIES

Oxytropis acuminata Nutt., "Fraser's Catal. No. 58. 1813," reprinted by Greene, Pittonia, 2:118. 1890, *nom. nud.*

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[19] I am indebted to my friend H. D. Ripley for translating the pertinent keys and descriptions from the Russian.

Described merely as perennial. No doubt Nuttall had in mind *O. Lambertii,* published by Pursh the year following, when already under cultivation in England.

Oxytropis acutirostris (Wats.) Jones, Proc. Calif. Acad. Sci., II, 5:677. 1895. *Spiesia acutirostris* (Wats.) Jones, *loc. cit. nom. provis. Aragallus acutirostris* (Wats.) A. Hell., Catal. N. Amer. Pl., p. 4, 1898.

This is the well known *Astragalus acutirostris* Wats., a desert annual of southern California and adjacent Nevada.

Oxytropis argentata auct.

Listed from Carlton House on the Saskatchewan by Richardson (Append. Frankl. Journ., 745. 1823). Not identified, but certainly neither the Altaic *O. argentata* (Pall.) Pers., nor the species indicated under the same name by Pursh, which is *O. Besseyi* (q. v.)

Oxytropis deflexa var? Port. & Coult., Syn. Fl. Colo., 31. 1874.

This unnamed variety was described from specimens collected by Coulter in the Horseshoe Mts., Colorado. No material with corresponding data has been seen, and the identity of the plant is hence uncertain. It may perhaps be referable to *O. deflexa* var. *deflexa,* which Coulter did collect in Gunnison County.

Oxytropis Lambertii β **leucophylla** Nutt. ex T. & G., Fl. N. Amer., 1:339. 1838, in syn.

See next entry.

Oxytropis Lambertii ε T. & G., Fl. N. Amer., 1:339. 1838.

This was quite fully described, but left without a name, Nuttall's var. β *leucophylla* being quoted merely as a synonym; so that the problem of its identity is academic from the nomenclatural point of view. It was based on a plant from "Plains of the Platte," but there seem to be no corresponding specimens either at Philadelphia or in the herbaria of Gray and Torrey. Since it was characterized as "very dwarf, canescently woolly . . . calyx densely woolly," there is an intriguing possibility that Nuttall may have encountered *O. Lagopus* var. *atropurpurea,* fairly common on barren hillsides of the North Platte valley in Wyoming.

Oxytropis Lambertii fma. **vivida** Ckll., Nature Notes (Selborne Soc. Mag.), 2:127. 1891 (1892?).

"West Cliff [Custer County], Colorado, near the waterworks, June 3, 1889." In the absence of specimens with these data it has been impossible to identify the name with assurance. Cockerell cited his new forma as an example of the effect of environment on the color of flowers, claiming that the white-flowered form of *O. Lambertii* (no doubt *O. sericea* var. *sericea* of this paper) was found in "moist, fertile places," and became bright purple when seeding into hotter and drier sites. It is possible that Cockerell had as fma. *vivida* one of the relatively uncommon purple-flowered phases of *O. sericea* (which do not, in the writer's experience, require more xerophytic conditions than the white-flowered form), but more likely it was *O. Lambertii* var. *Bigelovii,* the common Purple Loco of the region. At the time *O. Lambertii* and *O. sericea* were commonly held to be color-forms of one species.

Oxytropis Lambertii fma. **canadensis** Gand., Bull. Soc. Bot. France, 48: xvi. 1901.

Described from plants of southern Manitoba in the valley of the Souris River ("Portage-la-Prairie, *Macmorine, Fowler*"), neither of which has been seen. From lack of significant diagnostic remarks, and from the stated locality, fma *canadensis* can be taken with some assurance to be *O. Lambertii* var. *Lambertii.*

Oxytropis Lambertii fma. **pannosa** Gand., loc. cit., 1901, lapsu **O. pannosa.**"

The binomial "*O. pannosa,*" as taken up by Index Kewensis, was clearly a printer's error, since it was serially numbered as a forma under the preceding. The type was a plant from Fort Collins, Colorado, collected by Crandall. It is probably to be referred to the synonymy of var. *Bigelovii,* common in the foothills about Fort Collins, but the possibility exists that it was purple-flowered *O. sericea.* Crandall made several gatherings of *Oxytropis* in the region, but as Gandoger cited no date or number, it has been impossible to determine whether isotypes exist in this country. But the point is of little interest.

Oxytropis nothoxys (Gray) Jones, Proc. Calif. Acad. Sci. II, 5:677. 1895.
Aragallus nothoxys (Gray) A. Hell., Catal. N. Amer. Pl., p. 4. 1898.

Better known as *Astragalus nothoxys* Gray.

Oxytropis polaris Seem., Narr. Voy. Herald, 2:24. 1852.

Early and correctly transferred by Bentham to *Astragalus* (Trans. Linn. Soc., 23: 323. 1861).

Oxytropis sordida auct.

Tidestrom (Proc. Biol. Soc. Wash., 50: 18. 1937) listed *Astragalus sordidus* Willd. as American. The original species is a race or variety of *O. campestris* with large, more or less purple-tinted flowers common in high latitudes in Scandinavia east to Novaya Zemlya, but apparently Palearctic only. Bunge long ago pointed out the differences between the Old World plant and that of Labrador *(O. campestris* var. *terrae-novae)* which passed for some years as *O. campestris* var. *sordida;* cf. Fern., Rhodora, 30: 149. 1928.

Oxytropis uralensis auct.

This name was freely used by early authors for any dwarf silky *Oxytropis* with purple flowers, e. g.: Richards. Append. Franklin's Journ., 746—"*Arctic seacoast*" (probably *O. arctica);* Hook., Fl. Bor.-Amer., 1 :145; Nutt. Jour. Acad. Philad., 7: 18—"*Wyeth 25.*" These references have not been positively identified. In any case not the well known *O. uralensis* (L.) DC. of the Old World.

Oxytropis uralensis γ **minor** Hook., Fl. Bor.-Amer., 1: 146. 1834; T. & G., Fl. N. Amer., 1: 338. 1838.

This variety was briefly described as "glabriuscula, floribus paucis patulis purpurascentibus," the locality given as "Dry hillsides and prairies of the Rocky Mountains, *Drummond,*" and an additional collection from Labrador referred to it. None of the many specimens of *Oxytropis* sent to Torrey and Gray by Hooker is so labelled or seems to fit the description. The problem is nomenclaturally important in that var. *minor* could prove to be the earliest name in its category for either *O. viscida* var. *hudsonica* or *O. campestris* var. *terrae-novae.* The fact that var. *hudsonica* is glandular does not lessen the probability in the first case, since Hooker had another, even more conspicuously glandular *O. uralensis* var. *subsucculenta.* The Labrador plant mentioned by Hooker can have been nothing else but var. *terrae-novae;* and the recent report of var. *terrae-novae* from northwest Mackenzie makes it possible that the Drummond plant was conspecific after all (cf. discussion of *O. campestris* var. *terrae-novae,* above).

INDEX OF NAMES

(Synonyms and sensu-names in *italics;* new names and new combinations in **heavy bold-face.** Numbers and letters indicate numbered species and lettered varieties in the text. ES = Excluded Species. IS = Introduced Species)

PROCEEDINGS

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A PRELIMINARY REPORT ON THE BEHAVIOR OF THE PACIFIC SARDINE *(SARDINOPS CAERULEA)* IN AN ELECTRICAL FIELD

BY

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and NORMAN GRANT[*]

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Hermann (1885) found that small fish in a direct-current (d.c.) field of a certain density oriented themselves so as to face the anode, or positive pole, and swam toward that pole. When the current was reversed, the fish turned 180° and swam toward the other electrode, the new positive pole. This was confirmed by Blasius and Schweizer (1893), Nagel (1895), Scheminzky (1924), and others.

Since this early work, the galvanotropic reaction of fish has been utilized in this country in the development of electrical fish screens (McMillan, 1929); in the sampling of fresh-water fish populations by Haskell (1939), Haskell and Zilliox (1940), Larimore *et al.* (1950), and by several Canadian workers (Canadian Fish Culturist, 1950); and in studies now being undertaken to develop methods for the elimination of undesirable fresh-water fishes. Success has been reported in the use of electrical methods in commercial fresh-water fisheries in Russia by Chernigin (Anon., 1950) and in Germany by Denzer (1949).

Attention has most recently centered on the possible use of electricity in marine fisheries in Germany by workers utilizing equipment developed

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[*] This work has been done under the direction of, and with funds provided by, the Marine Research Committee as a part of the California Cooperative Sardine Research Program.

by Kreutzer and Peglow, as reported by Houston (1949). Since details of this equipment and the application of its use have not been made generally available, the research reported on below has been undertaken to determine the behavior of the Pacific sardine in an electrical field.

Although this research has been conducted on a laboratory scale thus far, the application of the principles involved to electrical fishing methods in marine fisheries may prove of great value. Such fishing methods may make possible the utilization of so-called ''wild'' schools of fishes and other marine fishes now difficult to obtain by the use of nets alone.

A wooden tank, 13′ 7½″ long, 20″ wide, and 12″ deep, filled with sea water to a depth of 6 to 7 inches was used (fig. 1). Temperature of the sea water during the course of the experiments varied from 14° C. to 16° C. The water was aerated at all times.

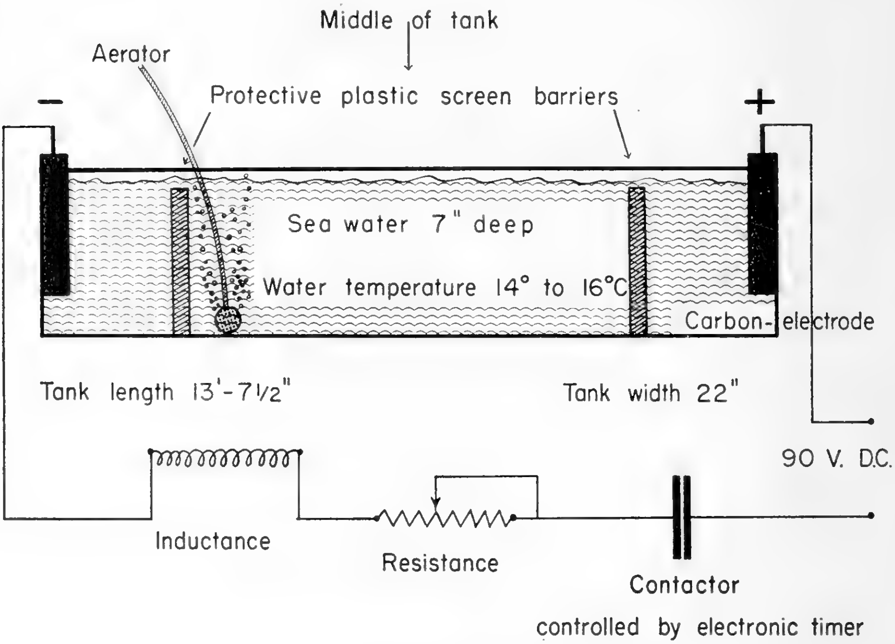

Figure 1. Diagram of experimental tank and electrical circuit.

Carbon electrodes measuring 5″ x 6″ x ¾″ were placed vertically at each end of the tank. Plastic screens were inserted 2 feet in front of each electrode to prevent direct contact with the fish. Pulsating direct current was supplied to the electrodes from a direct-current generator. The amount of current supplied to the tank was controlled by a variable resistor, and the wave form of the current impulse (fig. 2) was produced by the use of an inductance in the tank circuit. Timing of the impulses was controlled by an electronic timer which operated a small contactor to close and open the circuit. To check the wave form, an oscilloscope was included in the circuit. The circuit was arranged so that the polarity of the electrodes could be reversed.

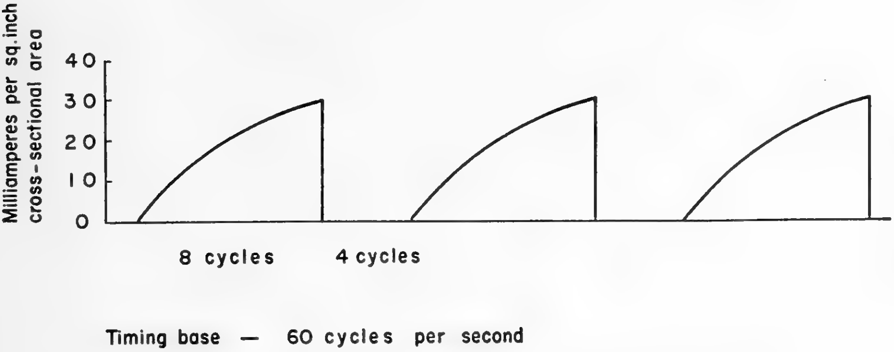

Figure 2. Diagram of effective electrical wave form.

Before each experiment the fish not previously tested were transferred from 1,000-gallon holding tanks to the experimental tank. They were permitted to remain undisturbed for a period of from 1 to 2 hours for purposes of acclimatization. The effectiveness of this acclimatization period was tested by the addition of live brine shrimp *(Artemia salina)*. Normal feeding behavior exhibited by the fish was used as an indication of their adjustment to the conditions of the experimental tank.

Following this period of acclimatization, from 2 to 4 fish were subjected to the various types of current listed below. Behavior patterns were recorded by an observer and by motion-picture photography. In all experiments the current density was within the limits of 15 to 35 milliamperes per square inch of cross-sectional area of water, unless otherwise stated.

The following types of direct current were found to elicit various reproducible responses on the part of the sardines:

1. Straight d.c. supplied by the d.c. generator (welding equipment).

2. Pulsating d.c. produced by hand switch or electronic timer with a pulsation rate of from 3 to 12 per second.

3. Pulsating d.c. with the current reduced to ½ ampere between pulsations.

4. Pulsating d.c. with the current cut to the zero point between pulsations, with the current on 2 times as long as off.

5. Pulsating d.c. with the current cut to the zero point between pulsations, with the current off 2 times as long as on.

The sardines were also tested with the types of electrical currents listed below, with variations in equipment used where necessary. None of these currents produced directional movements.

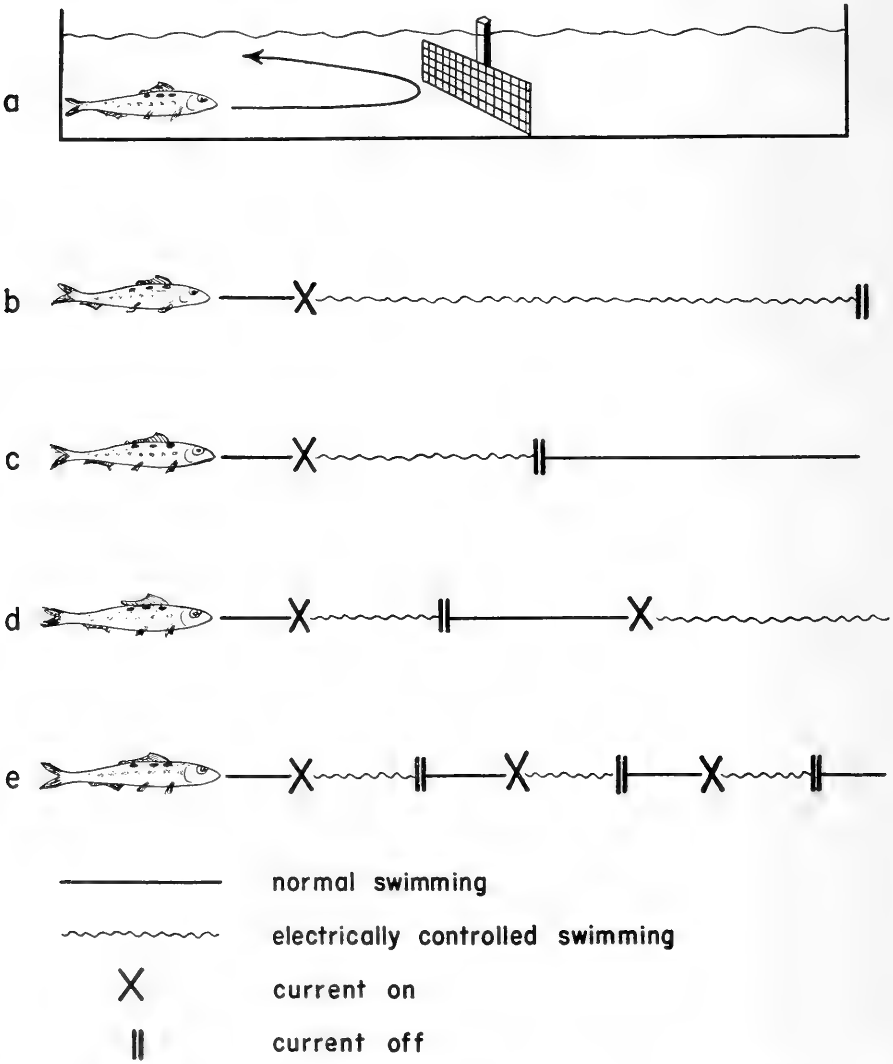

Figure 3. Diagram illustrating behavior of sardines in the absence and in the presence of an electrical field.

1. Rectified alternating current (a.c.) produced by a full-wave rectifier delivering a current with low pulsating peaks of 120 cycles per second.
2. Rectified a.c. with on-and-off pulsations from 3 to 20 cycles per second.
3. Condenser discharge produced by the use of an approximately 50 microfarad condenser with a voltage variation of from 100 to 600 volts. The frequency of discharge was varied from 4 to 8 per second.

The type of current found to be most effective in controlling sardine movements was a pulsating direct current (4, page 313) with the wave pattern shown in figure 2.

As can be seen in figure 2, the current density began at zero, increased to a maximum of 30 milliamperes per square inch of cross-sectional area of water for a duration of 8 cycles, and then returned to zero for 4 cycles. These pulses were repeated 5 times per second. Under the influence of this current, the fish immediately oriented themselves to face the positive pole and swam toward that pole. During the period of electrically controlled movement, the fish swam more slowly and laboriously than normal with no periods of relaxation. It appeared to the observer that the fish were being forced to swim.

Sardines swimming freely in the experimental tank did not show any set patterns of movement. Their swimming was continuous and they showed no preference for either end of the tank. Upon introduction of a plastic screen barrier, the fish exhibited typical fright reactions, such as an erratic increase in speed of swimming and immediate avoidance of the barrier by turning and swimming away from it (fig. 3a). Similar fright reactions resulted when the observer struck the water surface or sides of the tank with his hands, or when he moved a white object above the fish.

In the presence of an electrical field having the characteristics shown in figure 2, the behavior of the sardines changed markedly. This behavior may be grouped into four general classes as follows:

1. Fish facing the positive pole at the time the current was turned on continued to swim in a forced manner toward that pole (fig. 3b, c, d, and e). The type of swimming movements exhibited under influence of the current has been described above.
2. Fish facing the negative pole at the time the current was turned on oriented immediately to face the positive pole and swam in a forced manner toward that pole (fig. 4a and b).
3. When the charge on the poles was suddenly reversed during the forced swimming of the sardines, the fish reoriented to face the new positive pole and continued the forced swimming toward that pole (fig. 4c). This reversal of poles could be repeated many times with the same results (fig. 4d).

4. The insertion of a plastic screen between the sardines and the positive pole when the current was on resulted in no fright reactions. The fish struck the barrier and attempted to circumvent it. Those succeeding in bypassing the barrier continued their forced swimming toward the positive pole (fig. 4c). Under the influence of the current the sardines did not respond to such normally disturbing stimuli as vibrations, blows on the water surface, or the movement of white objects above them.

Topsmelt *(Atherinops affinis)* and northern anchovies *(Engraulis mordax)*, when subjected to the same current, behaved in an identical manner.

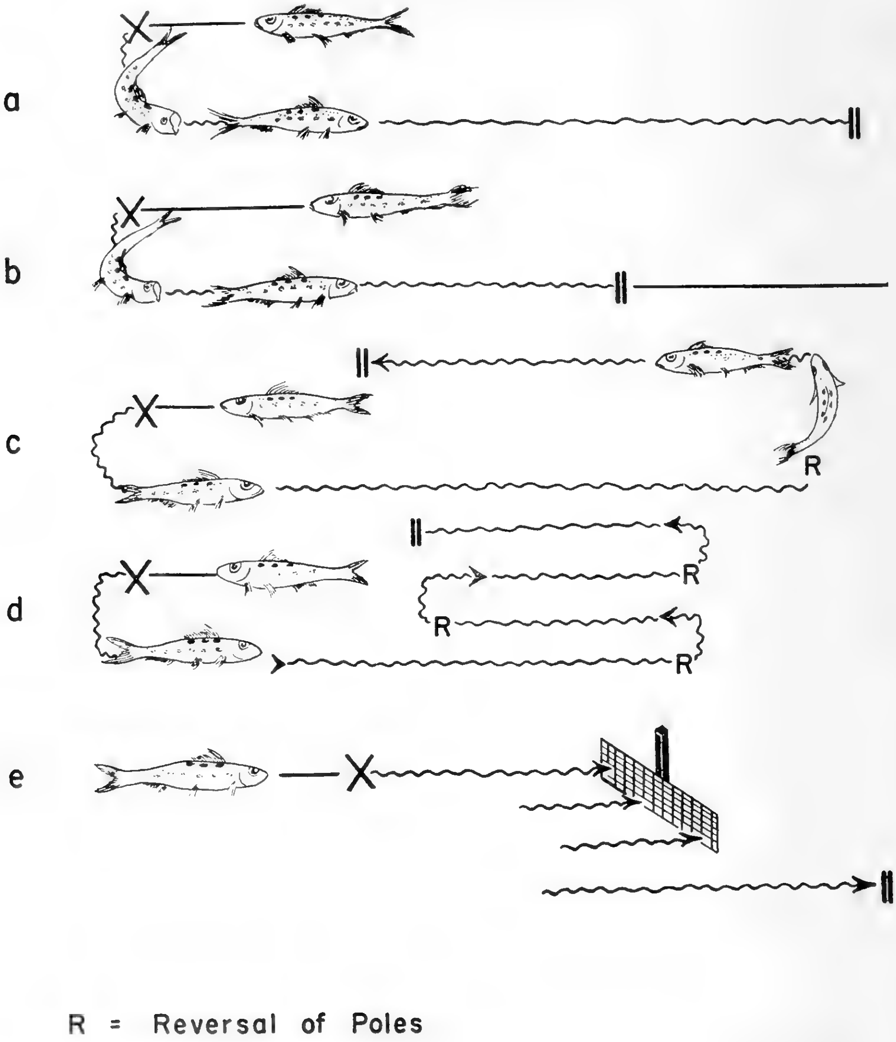

Figure 4. Diagram illustrating behavior of sardines in an electrical field.

It was found, however, that the current density required to produce these effects appeared to vary inversely with the size of the fish. For example, sardines 200 to 230 mm. in standard length oriented and swam toward the positive pole in a current with a density of 25 to 30 milliamperes per square inch. Topsmelt 110 to 120 mm. in standard length required a current density of from 35 to 40 milliamperes for the same response. This is in agreement with the findings of others (Houston, 1949).

Prior to the use of protective screens in front of the electrodes, some sardines were killed by coming into direct contact with the positive pole. After the addition of screens, no fatalities occurred, even after the fish had been intermittently subjected to the current for as long as 2 hours.

The period of captivity seemed to have no bearing on the reactions of sardines to electrical stimulation. Sardines recently received from San Diego responded in the same manner as sardines held under aquarium conditions for several months.

The current wave form (fig. 2) found to be most effective in producing directional swimming was varied in three ways; namely, by changes in (1) current density, (2) frequency of pulsations, and (3) relative duration of current-on periods to current-off periods. In order to determine the most effective combination of these variables, a series of tests were conducted utilizing the equipment and triangular wave form described above.

The conditions of the experiments were as follows:

Water depth	6 inches
Water temperature	14° C. to 18° C.
Number of fish each observational period .	4
Standard length of fish	200 mm. to 230 mm.
Duration of observational period	15 seconds
Position of fish when current is turned on .	Near negative pole
Type of test	Current on, then poles reversed three times

The current densities that were explored were 10, 15, 20, 25, and 30 milliamperes per square inch. Densities higher than 30 were found to be injurious and those lower than 10 were without effect. The frequencies of pulsation used were 2, 4, and 6 per second and the ratios of current-on to current-off periods were 1:3, 1:2, 1:1, 2:1, and 3:1.

For purposes of evaluating and recording the sardines' responses to the different combinations of these variables, the following definitions were used:

Perfect. When all four fish responded readily to each reversal of the poles and displayed a directional reaction toward the positive pole.

Good. When three of the four fish displayed the reaction given above or when all four fish failed to respond to one of the three reversals of poles.

Fair. When two of the fish readily responded to all pole reversals, or when all fish responded to at least two reversals.

None. When one or none of the fish displayed directional reactions.

In addition to the above definitions for recording behavior, records were made of the fishes' response to the current relative to fright reactions to stimuli and to apparent control of their own swimming movements. For these records, the following symbols were used:

(—). Swimming movements apparently under control of the fish, no directional response, and all reactions to fright stimuli retained.

(½+). The avoidance reaction to the barrier was retained, but the fish did not respond to vibrations of the tank with fright reactions.

(+). Directional responses apparently controlled by electrical current density only. Normal fright reactions to the barrier or to other stimuli completely lost.

(++). In addition to the reactions above under (+), the fish remained in contact with the protective screen next the positive pole as long as the current was on. This was, of course, the most pronounced reaction to the current short of stunning and death.

The method of varying the wave pattern consisted of maintaining each of two variables at the most effective level as determined from the earlier tests and changing the third variable according to the points listed above. For example, the pulsation rate was held at 4 times per second, and the ratio of current-on to current-off periods held at 2:1, while the current density was changed from 10 to 30 milliamperes per square inch by 5 milliampere increments. The density was then held at 30 milliamperes per square inch while the other variables were changed.

The most effective current densities were 25 and 30 milliamperes per square inch (table 1). Out of 180 tests for each of these densities, "satisfactory" results were obtained in 86.7 and 88.9 per cent respectively. These percentages were higher than those obtained for the lower densities. Accordingly, control of fish movement was "satisfactory" in 66.7 and 76.7 per cent of the tests at the two higher densities.

Four and six pulsations per second gave "satisfactory" results in producing directional reactions in 78.0 and 79.7 per cent respectively of 300 tests at each rate (table 2). Control of movement was "satisfactory" in 46.0 and 48.7 per cent of the tests at these rates.

The ratios of current-on to current-off periods found to give "satisfactory" results in directional reaction were 2:1 and 3:1, with 87.8 and 88.9 per cent respectively out of 180 tests at each ratio (table 3). Control of

TABLE 1

SARDINE REACTIONS TO VARIATIONS IN CURRENT DENSITY

Directional Reaction

Density in milli-amperes	Number of observations							Percentage of observations						
		Unsatisfactory			Satisfactory				Unsatisfactory			Satisfactory		
	None	*Fair*	*Both*	*Good*	*Perfect*	*Both*	*Total*	*None*	*Fair*	*Both*	*Good*	*Perfect*	*Both*	*Total*
10	41	61	102	69	9	78	180	22.8	33.9	56.7	38.3	5.0	43.3	100
15	8	62	70	79	31	110	180	4.4	34.5	38.9	43.9	17.2	61.1	100
20	6	30	36	82	62	144	180	3.3	16.7	20.0	45.6	34.4	80.0	100
25	2	22	24	76	80	156	180	1.1	12.2	13.3	42.2	44.5	86.7	100
30	0	20	20	65	95	160	180	0	11.1	11.1	36.1	52.8	88.9	100

Control of Movement

Density in milli-amperes	Number of observations							Percentage of observations						
		Unsatisfactory			Satisfactory				Unsatisfactory			Satisfactory		
	Minus	*½ plus*	*Both*	*Plus*	*Pl. plus*	*Both*	*Total*	*Minus*	*½ plus*	*Both*	*Plus*	*Pl. plus*	*Both*	*Total*
10	112	66	178	2	0	2	180	62.2	36.7	98.9	1.1	0	1.1	100
15	86	62	148	32	0	32	180	47.8	34.4	82.2	17.8	0	17.8	100
20	38	50	88	76	16	92	180	21.1	27.8	48.9	42.2	8.9	51.1	100
25	22	38	60	52	68	120	180	12.2	21.1	33.3	28.9	37.8	66.7	100
30	10	32	42	48	90	138	180	5.5	17.8	23.3	26.7	50.0	76.7	100

TABLE 2

SARDINE REACTIONS TO VARIATIONS IN CURRENT PULSATION RATE

Directional Reaction

Pulsations		*Number of observations*							*Percentage of observations*					
per		*Unsatisfactory*			*Satisfactory*				*Unsatisfactory*			*Satisfactory*		
second	*None*	*Fair*	*Both*	*Good*	*Perfect*	*Both*	*Total*	*None*	*Fair*	*Both*	*Good*	*Perfect*	*Both*	*Total*
2	24	101	125	107	68	175	300	8.0	33.7	41.7	35.7	22.6	58.3	100
4	16	50	66	132	102	234	300	5.3	16.7	22.0	44.0	34.0	78.0	100
6	17	44	61	132	107	239	300	5.7	14.6	20.3	44.0	35.7	79.7	100

Control of Movement

Pulsations		*Number of observations*							*Percentage of observations*					
per		*Unsatisfactory*			*Satisfactory*				*Unsatisfactory*			*Satisfactory*		
second	*Minus*	*½ plus*	*Both*	*Plus*	*Pl. plus*	*Both*	*Total*	*Minus*	*½ plus*	*Both*	*Plus*	*Pl. plus*	*Both*	*Total*
2	123	77	200	50	50	100	300	41.0	25.7	66.7	16.7	16.6	33.3	100
4	82	80	162	78	60	138	300	27.3	26.7	54.0	26.0	20.0	46.0	100
6	63	91	154	82	64	146	300	21.0	30.3	51.3	27.3	21.4	48.7	100

TABLE 3

SARDINE REACTIONS TO VARIATIONS IN RATIO OF CURRENT-ON TO CURRENT-OFF

Directional Reaction

Ratio of current-on to current-off	*Number of observations*							*Percentage of observations*						
		Unsatisfactory			*Satisfactory*				*Unsatisfactory*			*Satisfactory*		
	None	*Fair*	*Both*	*Good*	*Perfect*	*Both*	*Total*	*None*	*Fair*	*Both*	*Good*	*Perfect*	*Both*	*Total*
1:3	19	85	104	69	7	78	180	10.6	47.2	57.8	38.3	3.9	42.2	100
1:2	17	38	55	102	23	125	180	9.4	21.1	30.5	56.7	12.8	69.5	100
1:1	14	37	51	80	49	129	180	7.8	20.5	28.3	44.5	27.2	71.7	100
2:1	7	15	22	78	80	158	180	3.9	8.3	12.2	43.3	44.5	87.8	100
3:1	0	20	20	42	118	160	180	0	11.1	11.1	23.3	65.6	88.9	100

Control of Movement

Ratio of current-on to current-off	*Number of observations*							*Percentage of observations*						
		Unsatisfactory			*Satisfactory*				*Unsatisfactory*			*Satisfactory*		
	Minus	*½ plus*	*Both*	*Plus*	*Pl. plus*	*Both*	*Total*	*Minus*	*½ plus*	*Both*	*Plus*	*Pl. plus*	*Both*	*Total*
1:3	110	60	170	8	2	10	180	61.1	33.3	94.4	4.5	1.1	5.6	100
1:2	65	63	128	40	12	52	180	36.1	35.0	71.1	22.2	6.7	28.9	100
1:1	41	51	92	60	28	88	180	22.8	28.3	51.1	33.3	15.6	48.9	100
2:1	30	42	72	56	52	108	180	16.7	23.3	40.0	31.0	29.0	60.0	100
3:1	22	32	54	46	80	126	180	12.2	17.7	29.9	25.6	44.5	70.1	100

movement at these two ratios was "satisfactory" in 60.0 and 70.1 per cent of the tests.

These data tend to indicate that the most effective type of current producing directional swimming and electrical control of movements of the Pacific sardine is within the range of that diagrammed in figure 2. They also show that the rate of current pulsation as far as control of movement is concerned is of less importance than the other two variables.

The application of these tests to other species of marine fishes strongly indicates that detailed analysis of the current pattern will be necessary for each kind and size of fish before the method can be applied effectively in the capture of these fishes in the open ocean.

Whether the current found in the above experiments to regulate Pacific sardine movements in the laboratory will be as effective in the sardine fishery awaits development of equipment and methods of research for use on the fishing grounds.

SUMMARY

1. Pacific sardines *(Sardinops caerulea)* were found to respond to a pulsating direct electric current by orienting to face the anode and swimming toward that pole in a forced manner. Of the many types of current tried, the type of current wave form found to be most effective in causing this behavior was one in which the density began at zero, increased to a maximum of 30 milliamperes per square inch of cross-sectional area of water for a duration of 8 cycles, and then returned to zero for 4 cycles. Under the influence of this current the fish did not respond to stimuli normally causing fright reactions.

2. The current density required to produce directional swimming appeared to vary inversely with the size of the fish tested.

3. The fish were not killed by the above current as long as they were prevented from direct contact with the electrodes.

4. The period of captivity seemed to have no bearing on the response of the sardine to the electrical field.

5. Analysis of the relative effects of the three variables of this current, viz., density, pulsation frequency, and ratio of current-on to current-off period, tends to confirm the earlier findings that the most effective type of current producing directional swimming and electrical control of movements of the Pacific sardine is within the range of that stated above.

6. It is suggested that before the application of electrical fishing methods to marine fisheries can be made, detailed research to determine the current wave form most effective for each species and size of fish will be necessary.

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GEOLOGY OF THE CONTINENTAL SLOPE OFF CENTRAL CALIFORNIA

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Introduction

During the summer of 1949 arrangements were made by the Office of Naval Research and the California Academy of Sciences to undertake an exploration from a geological standpoint of the sea bottom off the coast of central California. The project took the form of a contract, No. N9 onr 94400. The net tender, U. S. S. *Mulberry,* Lieutenant James Birtch commanding, was assigned to the work, which was expected to continue for one year. The program provided for at least one week of each month to be spent at sea, a total of 12 weeks. Through urgent need for the *Mulberry* elsewhere, only 24 days were employed in actual exploration. Nevertheless a very considerable amount of material was collected and the present report covers the geological results. Much animal life was obtained incidental to the primary purpose of the exploration and this is expected to be considered in separate reports by various specialists.

Acknowledgments

The officials of the Office of Naval Research were most cooperative throughout the project. For handling the innumerable details we wish to thank especially Messrs. G. F. W. Mulders and J. E. Laurance.

The staff members of the Academy, Dr. R. C. Miller, Mr. W. I. Follett, Dr. Earl Herald, Mr. Robert P. Dempster, Dr. L. G. Hertlein, Mr. J. R.

Slevin, Mr. C. C. Church, Mr. F. L. Rogers, and many others have given advice and help most generously. Mr. Delbert Goodwin took care of records and cataloging of specimens for permanent preservation in a most creditable manner.

Mr. Charles Chesterman of the State Division of Mines undertook the difficult task of accurately identifying the rock specimens collected. His report follows this one.

To all of these the present writer is deeply grateful. Special appreciation is due Lieutenant James Birtch, the other officers, and the crew of the *Mulberry.* In handling the ship and equipping it for this special duty, their enthusiasm and energy were unbounded.

There have been many occasions in the past when close cooperation of the activities of the Academy and various governmental organizations has been most beneficial. In the present instance it is a pleasure to record the assistance given by the U. S. Coast and Geodetic Survey. Through Captain (now Admiral) R. F. A. Studds much information was obtained regarding the offshore topography, and especially, details pertaining to the discovery and survey of the seamounts. Photostatic copies of the original field sheets were supplied to us; they contain the records of many hundreds of depth readings which do not appear on the published sailing charts.

Thanks are also due the U. S. Coast Guard. Commander Henry F. Stolfi of that service made it possible for Mr. Allyn Smith and me to spend a week on the Farallon Islands in June, 1949. This visit was made primarily to secure information regarding the geology of these offshore islands for use in connection with the investigation of the bottom rocks if and when this should be undertaken. Dr. Olaf P. Jenkins of the California State Division of Mines and Mr. M. Vonsen assisted materially in evaluating the results of that investigation.

Finally, the interest which the California Division of Fish and Game has maintained in this work has been invaluable. Details appear later in this report but here it should be stated that during September and October, 1950, it was my privilege to accompany the motor vessel, *N. B. Scofield,* on a trip as far north as Eureka. Arrangements were made through Mr. Richard Croker, chief of the Bureau of Marine Fisheries, and the field work was in charge of Mr. William Ellis Ripley, Mr. Julius B. Phillips, and Mr. Keith W. Cox. Much bottom trawling was done and special efforts were made on many occasions to secure material for the Office of Naval Research Project. The results of this investigation are incorporated in the present report, insofar as they have a bearing on the offshore geology. A preliminary account of this work, supplied by Mr. Ripley but unsigned by him, appeared in Pan-American Fisherman, Vol. 5, No. 6, Dec. 1950, p. 14.

PREVIOUS WORK IN SAME AREA

The Coast and Geodetic Survey came to California soon after the area became a part of the United States and immediately began investigations of offshore waters and bottom conditions. This work was carried on primarily for furnishing aid to mariners and has resulted in continuously improved sailing charts. Many thousands of soundings were made which, until recently, consisted of letting a weight to bottom on a measured line. This gear often brought up samples the nature of which was recorded on the charts in the form of letters or symbols. The later work has been done with sonic equipment, which gives a much more detailed topographic map of the bottom and is much more economical in operation, but gives little if any indication as to the nature of the bottom. The sailing charts used in connection with the present investigation were as follows, listed in order, from Point Sur north to Cape Blanco, Oregon:

1. 5402. Point Sur to San Francisco
2. 5502. San Francisco to Point Arena
3. 5602. Point Arena to Trinidad Head
4. 5702. Trinidad Head to Cape Blanco

At least two surveys were made across the Pacific from California to Hawaii for a submarine cable route. One was by the *Tuscarora* in 1874. The next was by the U. S. S. *Albatross* in 1891–92 (Tanner, 1894, pp. 12–23; Anonymous, 1892). This line extended on the great circle from Moss Landing in Monterey Bay to Oahu. On return a rhumb line was run to the southward. In both surveys many soundings were made and bottom samples were recovered and briefly described.

The U. S. S. *Albatross* also made a biological survey of Monterey Bay in 1904 during the course of which 128 stations were occupied. Details of this work are given by the U. S. Bureau of Fisheries (1906, pp. 1–43). Three stations, D. 4565, D. 4566, and H. 8404, were occupied outside the Golden Gate and 9 miles south of Southeast Farallon Island in 22 and 495–587 fathoms. The bottom was gray sand in the shallow haul and blue and green mud with rock in the deep ones.

In 1912 and 1913 a more detailed survey was made of San Francisco Bay and a few stations were occupied off the Golden Gate. Several publications have appeared on this work. The details of stations occupied are given by the U. S. Bureau of Fisheries (1921, pp. 20–80). Eight stations were occupied outside the Golden Gate in water less than 100 fathoms in depth and in all of which the bottom was reported to be sand. Packard (1918) has described the mollusks obtained. In the same serial the physical conditions are described by Sumner, Louderback, Schmitt, and Johnston (1914).

While the *Albatross* was engaged in survey work primarily concerned with the fisheries of the Pacific, a great deal of time was spent in California or adjacent waters. Dredging, trawling, and sounding were conducted for many years and a wealth of information was secured. Bottom conditions were recorded briefly and in some cases samples were preserved. The disposition of these samples has not been traced.

Many thousands of stations were occupied by the *Albatross* up to 1920. The places where the lists are published are given in detail by MacDonald (1921, pp. 20–21).

The work outlined above has resulted in the accumulation of much valuable information; it is of a generalized nature, however, from a geologic standpoint. So far as I have found none of the samples of bottom collected were examined or reported upon by geologists and most of them almost certainly have been lost.

A long series of submarine geological investigations have been made during recent years in waters off southern California and to the southward under the guidance and inspiration of Dr. F. P. Shepard of the Scripps Institution of Oceanography, La Jolla, California. This work, conducted by highly trained personnel with adequate gear has set new standards and opened up new fields of exploration which have application and implication in many lines of endeavor. A long series of publications have resulted. They are adequately listed and reviewed in two recent documents on submarine geology (Shepard and Emery, 1941, and Shepard, 1948).

While the work just mentioned is of utmost importance, most of the exploration for it was conducted south of Point Conception. The paucity of information pertaining to the offshore geology of northern California had definite bearing upon the schedule outlined for the present undertaking. A very useful reference work on submarine geology was published by Geyer (1948).

I became interested in this subject in 1940 when I was permitted to accompany an expedition along the northern California coast by the California Division of Fish and Game. The vessel used was the *N. B. Scofield*. The objective was primarily the investigation of bottom fishes but light dredges were attached to the trawl to secure bottom samples. Many specimens of rocks were obtained and have been preserved by the California Academy of Sciences. The most interesting perhaps was granodiorite in about 30 fathoms on Cordell Bank west of Point Reyes. In following up this investigation it was learned that there were practically no reliable records concerning the geology of the substratum off northern California.

The literature gave no conclusive answer as to the nature of the rocks on the Farallon Islands themselves. No geologist had apparently ever visited them and records based upon observations by botanists and ornithologists were in conflict.

Resumption of the work was delayed until May, 1948, when arrangements were made with the U. S. Coast Guard Service to spend one week on Southeast Farallon Island in company with Mr. Allyn G. Smith. This is the island upon which the lighthouse establishment is located. Every accessible part of the island was visited and many samples of the rocks were collected. A special report upon the island was prepared for the California State Division of Mines (Hanna, 1951).

It was found that the southeast island with outlying rocks is composed of a highly jointed and fractured granodiorite, very uniform in composition throughout. No dikes of accessory minerals were observed and inclusions are exceedingly rare. This is in marked contrast to the nature of nearest exposures of similar rocks on the mainland, namely Point Montara and Point Reyes. The surface on the island is deeply weathered and shore lines are marked by abrupt cliffs, sea-cut caves, and surge channels. Remnants of at least three elevated terraces are present, the most obvious one being about 50 feet above present sea level. It is possible that the entire island, now 340 feet high was once submerged. Scattered at random all over the surface there are rounded pebbles of foreign rock, mostly jaspers similar to those derived from the Franciscan chert of the mainland. These pebbles vary in size up to four inches in diameter. No thoroughly satisfactory explanation of their presence has been suggested. Possibly one of the following may be the correct one:

1. These pebbles may be remnants of a conglomerate which once covered the island but is now, as such, completely eroded away. In support of this theory there may be cited the presence of a conglomerate containing similar pebbles on the flanks of Cordell Bank to the northward. Abundant evidence of this was obtained in the present investigation. This theory may involve complete submergence of the island.

2. The island was once occupied by a very large colony of fur seals and possibly sea lions. These animals swallow rounded pebbles consistently and often regurgitate them when they go ashore. This is well known to all who have had experience on fur seal rookeries. The pebbles on the Farallon island are usually of about the size such animals would choose.

3. The island has been occupied more or less continuously since about 1800 by man. In connection with some of the modern installations, rock, sand, and cement have been used extensively and nearly all of this has been transported from the mainland. Such operations, however, do not account for the presence of the pebbles in the more distant and inaccessible parts of the island. Early occupants, the fur seal hunters and the egg gatherers, would almost certainly not carry pebbles to such a barren rock as Southeast Farallon and scatter them over the surface.

4. The island is still occupied by a great many sea birds but it is not known that any of the numerous species found there ever carry pebbles from one place to another.

SCOPE OF WORK AND GEOLOGICAL RESULTS

In the original outline of the project it was planned to run cross sections from the 100 fathom curve out to oceanic depths at four places along the central California coast: outwardly from Point Montara across the Guide and Pioneer seamounts; outwardly from Point Bonita past the south end of Farallon Island; and due west from Point Reyes across Cordell Bank. If time permitted similar sections would be run to the northward. As it worked out this schedule could not be followed closely for various reasons and the detail of the ship elsewhere cut the work short.

It took some time to devise the best sort of gear for the task and to learn how to use it. The vicinity of Cordell Bank was believed to be the best location for this experimental study. It offers suitable anchorage at night in good weather and in case of trouble Drakes Bay is close at hand for shelter. Therefore, more details were secured in the vicinity of that bank than elsewhere.

It was found that the top is composed of jagged granodiorite rocks, essentially like those exposed in air on Southeast Farallon Island. The minimum depth is 28 fathoms. The bottom slopes gently to the eastward toward Point Reyes to 70 fathoms, a dredge haul made in 1940 indicating that the bottom in the trough is mud. On the east flank of the bank we obtained large quantities of pebbles and boulders, obviously weathered out of a conglomerate. The rocks consisted of many types foreign to any outcrop now existing on the mainland. It is significant to note that a very extensive conglomerate outcrops at present on the north end of Point Reyes promontory and that this rests on granodiorite also. A comparison of the pebbles we dredged with those of Point Reyes would be instructive.

To the west of Cordell Bank the continental slope is exceedingly steep and descends to oceanic depths in a few miles. We found granitic rocks down to 74 fathoms and lost a dredge in 200–400 fathoms. Green mud was found at 1140–1500 fathoms and again at 2000 fathoms.

On the northwest flank of the bank, however, an excellent dredge haul was made in 400–200 fathoms (Sta. 56) and about 500 pounds of rocks was obtained; these appear to be predominantly phosphate.[1]

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[1] Dr. Durham of the Museum of Paleontology, University of California, has lately received a piece of hard sandstone which was brought up by a fisherman from Cordell Bank. This rock contains several well preserved specimens of *Thyasira disjuncta* Gabb, and furnishes the first definite evidence of the age of the strata which are closely associated with the granitic rocks of this bank. This fossil is found commonly in Miocene rocks of the west coastal areas.

While our main problem was not the investigation of submarine canyons and we had no intention of discussing them in any way, we found it convenient to make a dredge haul in Bodega Canyon which lies a short distance to the north of Cordell Bank. A position was chosen as nearly in the trough as possible (Sta. 8) in 123–112 fathoms. A large quantity of green mud unaccompanied by rocks was obtained.

Southeast Farallon Island, Middle Farallon, the group of rocks known as North Farallon, and the submerged banks called Noonday Rock, Fanny Shoals, and Cordell Bank, lie on a northwest–southeast line, parallel to the major topographic features of the California coastal region. The discovery that the northern and southern limits were granitic at once raised the question as to the possibility of there being outcrops of similar rocks between the various highs. Several dredge hauls were made to determine this point but in no case did they disclose information which would lead to the belief that such is the case. Some evidence of loose gravel and boulders was obtained but we did not encounter what we could identify as rock in place in any of the attempts. Additional investigation of this feature would be worthwhile.

In this connection an attempt was made to land on one of the North Farallon rocks but this could not be done in safety. At close range from the row boat the rocks appeared to be massive granodiorite. There is a little vegetation on one of them. They are large bird rookeries and a considerable number of sea lions haul out on them.

Immediately to the westward, that is on the continental slope outside of the Farallon Ridge and immediately to the southward, several dredge hauls yielded only sedimentary rocks in place. Excellent Miocene shales and cherts were obtained. The shales contained well-preserved assemblages of foraminifera and diatoms and these rocks extend down to 1150 fathoms (Sta. 62). There was no evidence that these had tumbled down the slope from a higher level; in fact many of the shales were too friable to withstand transport at all.

Farther south on the slope some shales had the appearance of Pliocene outcrops along the coastal shores but the fossils contained in them have not been accurately determined. At one place (Sta. 45) near the head of Pioneer Sea Valley about 200 pounds of dense phosphatic rock was obtained. Some light-colored shale-like material of unknown origin was with it.

When the U. S. Coast and Geodetic Survey announced the discovery of some high submarine mountains about 75 miles southwest of the Golden Gate a few years ago there was considerable comment in the newspapers about them. From a geological standpoint it was important to learn if the rocks found on them were related to those of adjacent continental areas or possibly to submerged land masses to the westward. In any case they do not line up with known topographic features. Some of the strata of the Coast Ranges of California as young as early Tertiary (San Onofre breccia for instance) contain detrital material which can be traced to no known outcrops. This has caused some to assume that at one time there was land of continental proportions west of what is now California, and from which eastward flowing streams brought these sediments. If these seamounts be remnants of such a land mass corroborative evidence would be at hand. Therefore we made

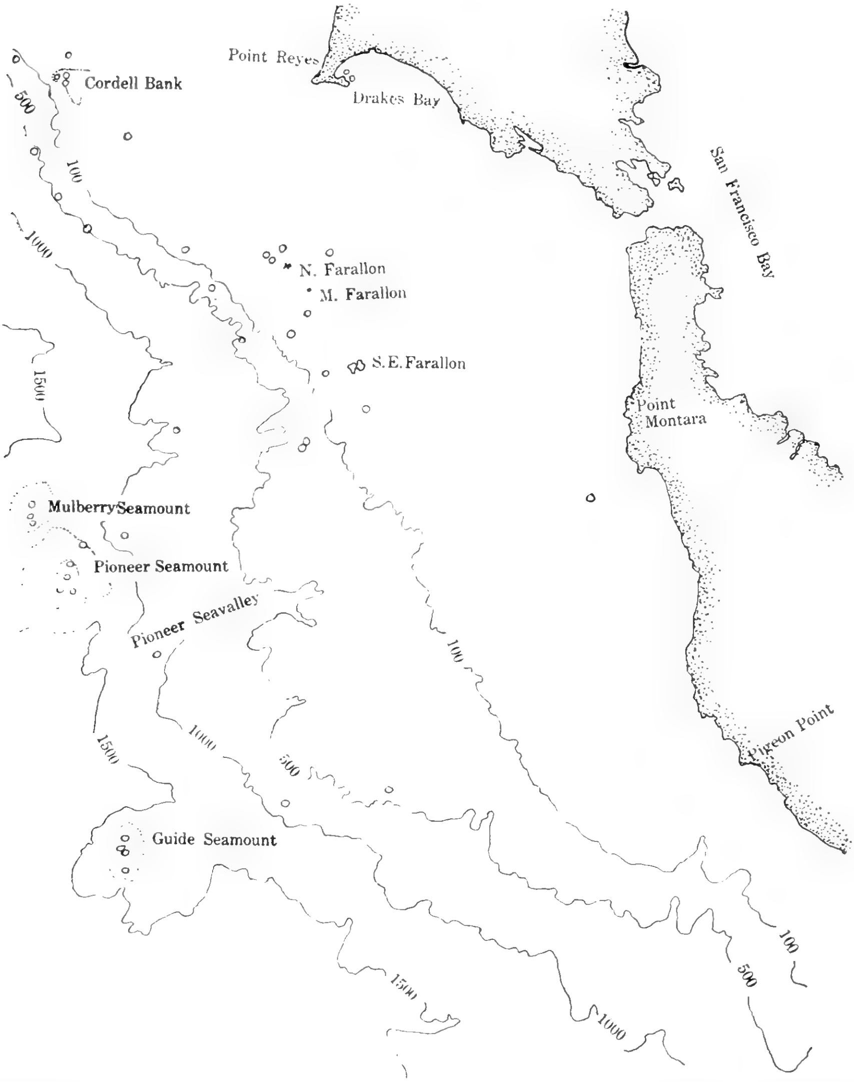

Figure 1. Sketch map of the area off central California where most of the dredging was done. Circles indicate some of the stations. Contour interval, 500 fathoms outside of the 100 fathom line.

numerous dredge hauls on the sides and tops of the mounts and actually anchored one night on one of them in 900 fathoms.

There are really three of these seamounts: Guide to the southward, Pioneer to the northward, and a smaller one which we called "Mulberry" immediately to the north of it. On the Guide we obtained only mud in the dredge; if rock outcrops be present (and they probably are) we failed to locate them. On Pioneer several hundred pounds of basaltic material was dredged. Much of this is altered somewhat, especially in the outer layers. It contains titaniferous augite and in this respect is unlike the volcanic material found in the adjacent coastal mountain ranges. Some large blocks of the material seem to be altered completely or almost completely to phosphatic minerals. This high alteration was not present in the rocks dredged on "Mulberry" Seamount. In fact most of them have a very "fresh" appearance and many are so vesicular that they are scoriaceous. No phosphatic alteration was noticed in hand specimens.

On Pioneer Seamount there were very few living organisms. Large numbers of huge siliceous sponges were obtained but none were living. No adequate explanation of this condition was available; it may simply have been the result of accidental location of the dredge hauls. On "Mulberry" Seamount, on the contrary, every haul yielded a considerable number of living animals, attached to the rocks and otherwise.

It had been hoped that this work might be extended to the northward off Mendocino and Humboldt counties but before it could be undertaken the field work was suspended. However, an opportunity was presented to secure a limited amount of material when the California Division of Fish and Game sent its vessel, the *N. B. Scofield,* to that area in the fall of 1950. The primary objective was the investigation of bottom living fishes with trawls. Since many specimens of biological interest are inevitably obtained in such work, the stations of this trip are included in the tabulation herewith. A haul was made with the dredge in Mattole Canyon off Punta Gorda and it was hoped that material would be secured which would give a clue as to the nature of the great seacliff which extends westward for more than 100 miles offshore. The recovery, however, consisted almost entirely of well-rounded pebbles of sedimentary rocks such as are found on nearby shores in the Cretaceous.

The trawling work off Eureka bar produced numerous pieces of Wildcat (Pliocene) formation and fortunately some of these contained diagnostic megafossils. This formation covers an extensive area in the Eureka district and the present work shows that it extends out to sea at least 30 miles and to the depth of 80-120 fathoms.

Along commercial shipping lanes it is not unusual to dredge up cinders, bottles, cans, and debris of many kinds. Most of this can be readily identified and explained. However, the presence of occasional well-rounded pebbles or boulders generally distributed, even out where the bottom is sand or mud,

COLLECTING STATIONS

Station No.	Haul No.	Date	General Locality	Position N. Lat.	Position W. Long
1	1	8/23/49	10½ miles west of Point Reyes light	38°–00′	123°–14.7′
1	2	8/23/49	10½ miles west of Point Reyes light	38°–00′	123°–14.7′
1	3	8/23/49	10½ miles west of Point Reyes light	38°–00′	123°–14.7′
2		8/23/49	East side of Cordell Bank; 16¾ miles west of Point Reyes light	38°–00′	123°–22.4′
3		8/23/49	Cordell Bank	37°–59.7′	123°–25.2′
4		8/23/49	Cordell Bank	38°–00′	123°–30.8′
5	1	8/23/49	Cordell Bank bears 180°T., 3½ miles distance	38°–07.5′	123°–26.5′
5	2	8/23/49	Cordell Bank bears 180°T., 3½ miles distance	38°–07.5′	123°–26.5′
6		8/24/49	Cordell Bank bears 90°T., 30 miles distance	38°–00′	124°–04.5′
7	1	8/24/49	Northwest side of Cordell Bank	38°–03.3′	123°–31.2′
7	2	8/24/49	Northwest side of Cordell Bank	38°–03.3′	123°–31.2′
8		8/24/49	Northeast side of Cordell Bank	38°–07.5′	123°–23.6′
9	1	8/24/49	Cordell Bank	38°–02′	123°–24.8′
9	2	8/24/49	Cordell Bank	38°–02′	123°–24.8′
10		8/25/49	Cordell Bank	38°–02.2′	123°–24.8′
11	1	8/25/49	Southwest of Cordell Bank	37°–59.2′	123°–27.0′
11	2	8/25/49	Southwest of Cordell Bank	37°–59.2′	123°–27.0′
12		8/25/49	Cordell Bank bears 14°T., 3¾ miles distance	37°–54′	123°–25.7′
13	1	8/25/49	Northeast of North Farallon	37°–47′	123°–04.6′
13	2	8/25/49	Northeast of North Farallon	37°–47′	123°–04.6′
14		8/26/49	Southeast Farallon light bears 103°T., 9.2 miles distance	37°–43.8′	123°–11.3′
15	1	9/26/49	Cordell Bank	38°–00′–30″	123°–25′–15″
15	2	9/27/49	Cordell Bank	38°–00′–30″	123°–25′–15″
16		9/27/49	Cordell Bank bears 86°T., 31 miles distance	38°–00′–40″	124°–07′–00″
17	1	9/27/49	Cordell Bank	38°–02′–30″	123°–26′–30″
17	2	9/28/49	Cordell Bank	38°–02′–30″	123°–26′–30″
18		9/28/49	Cordell Bank bears 100°T., 8.4 miles distance	38°–02′–30″	123°–36′–15″

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* Dredge time is considered as bottom time only.
Double line across chart indicates new trip to location.

COLLECTING STATIONS—(Data continued)

Depth in Fathoms	Duration of Haul*	Net Type	Bottom and Content
60	0700–0715	Rectangular dredge	Dredge lost
60	0740–0745	Round dredge	
60	0910–0930	4′x5′ trawl	
57–50	1015–1035	Round dredge	Much rock; 2 small flatfish
34	1200–1500	Handline	14 rockfish
400–200	1515–1630	Round dredge	Dredge contents lost
35	1645–1800	Handline	24 rockfish
Surface	1900–2200	Night light	Few sauries
—	0900–1100	Observation	Searching for albacore
124–90	1300–1345	Round dredge	1 agonid
90–80	1400–1410	4′x5′ trawl	Net ripped; frame O. K.
123–112	1600–1630	Round dredge	Green mud; small shrimps
28	1635–1830	Handlines	18 rockfish
Surface	1800–2200	Night light	Sauries only
34	0800–0810	Round dredge	Rocks
74	0845–0900	Round dredge	Solid granite
74	0915–1930	Round dredge	Green mud
218–100	1100–1130	Round dredge	Conglomerate and mud
42	1530–1900	Handlines	Many flatfish, 1 lingcod
Surface	1900–2100	Night light	Sauries only
126–70	0905–0930	Round dredge	Sterile green mud
Surface	1930–2200	Dip nets, night light	48 sauries
34	0600–0730	Hook and line	Rockfish
2000	1028–1650	Rectangular dredge	Green mud; 1 tunicate
Surface	1930–2300	Trap and night light	127 sauries; 1 jackmackerel
40	0600–0730	Hook and line	Many rockfish
1000	1140–1500	Round dredge lost; Rectangular dredge used	Green mud; 1 crab, 1 shark sighted

COLLECTING STATIONS—(Continued)

Station No.	Haul No.	Date	General Locality	Position N.Lat.	Position W. Long.
19		9/28/49	Cordell Bank bears 347°T., 6.2 miles distance	37°–55′–15″	123°–24′–05″
20		9/28/49	Cordell Bank bears 320°T., 8.2 miles distance	37°–55′–45″	123°–19′–15″
21		9/29/49	Cordell Bank	38°–00′–15″	123°–26′–00″
22		9/29/49	Fanny Shoal bears 90°T., 8 miles distance	37°–48′–40″	123°–23′–00″
23		9/29/49	Fanny Shoal bears 90°T., 3 miles distance	37°–47′–00″	123°–13′–50″
24			North Farallon bears 178°T., 600 yards distance	37°–46′–30″	123°–06′–00″
25		2/6/50	Pioneer Seamount; Farallon light bears 46°T., 27¾ miles distance	37°–22.8′	123°–25′
26		2/6/50	NE. Pioneer Seamount; Farallon light bears 43°T., 23.2 miles distance	37°–25.2′	123°–20′
27		2/7/50	Pioneer Seamount	37°–24.4′	123°–23.5′
28		2/7/50	Pioneer Seamount	37°–21.0′	123°–25′
29		2/7/50	Pioneer Seamount	37°–21.0′	123°–25.8′
30		2/7/50	Pioneer Seamount Anchorage	37°–22.0′	123°–25.2′
31		2/8/50	Southwest of Pioneer Seamount	37°–18.7′	123°–28.2′
32		2/8/50	Mulberry Seamount	37°–26.5′	123°–28.7′
33		2/8–9/50	1½ miles west of Farallon light	37°–41.9′	123°–2.2′
34		2/9/50	Farallon light bears 12°T., 10.4 miles distance	37°–31.9′	123°–2.8′
35		2/9/50	Farallon light bears 12°T., 10 miles distance	37°–32.3′	123°–2.7′
36		2/9/50	Farallon light bears 180°T., 4.4 miles distance	37°–46.4′	123°–00′
37		2/9/50	Farallon light bears 340°T., 8 miles distance	37°–34.6′	122°–56.5′
38		2/13/50	Mulberry Seamount	37°–26.5′	123°–28.7′
39		2/13 14/50	Mulberry Seamount		

* Dredge time is considered as bottom time only.
Double line across chart indicates new trip to location.

COLLECTING STATIONS—(Data continued)

Depth in Fathoms	Duration of Haul*	Net Type	Bottom and Content
68–70	1624–1700	Rectangular dredge	Rocks; invertebrates; 1 shark and 1 ratfish egg-case
62–60	1715–1755	Rectangular dredge	Rock fragments and mud; invertebrates; 1 ratfish egg-case
28	0600–0700	Hook and line	Rockfish
400	0843–1000	Rectangular dredge	Mud and invertebrates; 3 shark egg-cases
62	1135–1210	4′x5′ trawl	Net ripped; frame O. K.; few box crabs
28	1330–1445	Hook and line	Nothing caught
480–450	1610–1630	12″ round dredge	Rocks and green mud; sponges
800–1000	1905–1950	Fish net	Cable broke, net lost
700–500	0815–0850	15″ round dredge	3 volcanic rocks, new sp. of chiton
600–450	1140–1240	12″ round dredge	Dead sponges
440–540	1340–1430	2½′x4′ dredge	400 lbs. of rocks
460	1930–2200	Setline (vertical)	Hooks wrapped around the cable; no fish
1300–1500	0935–1220	15″ round dredge	Small amount of green mud
1000–700	1700–1850	15″ round dredge	Rocks; skate egg and embryo; gorgonias
33	2145–0700	Handlines, night light	Many invertebrates, 1 starfish
320–250	0900–0935	12″ round dredge	Sack of green mud; *Macoma* sp.
340–120	1015–1110	12″ round dredge	3 pieces of mud; 1 echinoid 1 *Calliostoma platinum* (3rd specimen)
80–65	1130–1230	2½′x4′ dredge	2 sacks of green mud; many shells
55–46	1250–1340	2½′x4′ dredge	Mud; few shells; basket-star
690–800	1500–1630	15″ round dredge	Rocks and shells
800	Overnight	Groundline	No results

COLLECTING STATIONS—(Continued)

Station No.	Haul No.	Date	General Locality	Position	
				N. Lat.	W. Long
40		2/14/50	Guide Seamount		
41		2/14/50	Guide Seamount	37°–01′	123°–20′
42		2/14/50	Top of Guide Seamount	36°–59′–30″	123°–20′
43		2/14/50	Guide Seamount	37°–02′	123°–20′
44		2/15/50	Guide Seamount	37°–01′–30″	123°–20′–30″
45		2/15/50	Guide Seamount bears 256°T., 13 miles distance	37°–04′–30″	123°–04′–30″
46		2/15/50	Guide Seamount bears 258°T., 21 miles distance	37°–05′–30″	122°–55′
47		2/16/50	Pioneer Seamount bears 10°T., 9 miles distance	37°–16′	123°–17′
48		2/16/50	Head of Pioneer Sea Valley	37°–20′	123°–45′
49		2/16/50	Point Montara light bears 30°T., 5½ miles distance	37°–27′–30″	122°–34′–30″
50		2/17/50	Southeast of Farallon, light bears 346°T., 16¾ miles distance	37°–25′–45″	122°–55′
51		2/17/50	16 miles south of Farallon Island	37°–25′	122°
52		3/27/50	Farallon light bears 73°T., 7 miles distance	37°–40′	123°–08.5′
53		3/27/50	Farallon light bears 05°T., 4½ miles distance	37°–37′–25″	123°–00′–25″
54		3/27/50	Farallon light bears 244°T., 3½ miles distance	37°–40′–30″	123°–03′–50″
55		3/28/50	Drakes Bay anchorage	38°–02 –20″	122°–57′–06″
56		3/29/50	Northwest of Cordell Bank	38°–03′–50″	123°–33′–30″
57		3/29/50	Southwest of Cordell Bank		
58		3/29/50	West of Cordell Bank	38°–00′–30″	123°–33′
59		3/29/50	Cordell Bank anchorage	37°–59′–55″	123°–25′

* Dredge time is considered as bottom time only.
Double line across chart indicates new trip to location.

COLLECTING STATIONS—(Data continued)

Depth in Fathoms	Duration of Haul*	Net Type	Bottom and Content
950–1400		15″ round dredge	No results
100+		1 meter tow net	Jelly fish
100	1500–1600	1 meter tow net	Line fouled up; no results
Surface	0800–0900	1 meter tow net; dip net	Many fish, jelly fish
1300–1380	0900–1200	15″ dredge, lost, trawl	Small amount of mud
600–400	1600–1800	15″ round dredge	500 lbs. of rock and mud
Surface	1800–2100	1 meter tow net	Many pelagic organisms
1000–640	0800–1000	15″ round dredge	Mud washed out of dredge
341–100	1000–1300	15″ round dredge	Green mud; gastropods, echinoids
Surface	Overnight	1 meter tow net	Great haul of jelly fish tore the net
200	0800–1000	15″ round dredge	2 gallons of green mud; few pieces of granite
180–80	1030–1150	15″ round dredge	1000 lbs. of rock and sticky blue-green mud
300		15″ round dredge	Sand bottom, 1 crab, 11 *Chrysodomus*
65		Tow net	
45–55		1′ dredge	Crinoids, ophiuroids, gastropods; few rocks of granite and conglomerate mud
5		Tow net, night light, dip net, and hook and line	Starry flounder, asteroids, shrimp, echinoids
400–200		Round dredge	800 lbs. of rock; 1 gorgonian
400		Tow net	2 fish; shrimp
600		Tow net	1 squid, shrimp, few lantern fish, jellyfish
35		Lights, hook, and line	Many fish; young decapods, jellyfish

COLLECTING STATIONS—(Continued)

Station No.	Haul No.	Date	General Locality	Position	
				N. Lat.	W. Long
60		3/30/50	Cordell Bank bears 10°T., 7 miles distance	37°–54′–30″	123°–28′
61		3/30/50	Cordell Bank bears 05°T., 10 miles distance	37°–51′	123°–26′
62		3/30/50	Farallon light bears 358°T., 18 miles distance	37°–42′–30″	123°–23′
63		3/31/50	North Farallon anchorage	37°–46′–15″	123°–06′–00″
64		4/6/50	Farallon light bears 53°T., 14¾ miles distance	37°–33′	123°–15′
65		4/6–7/50	Mulberry Seamount anchorage	37°–27′–25″	123°–28′–30″
66		4/7/50	Drakes Bay	38°–00′–30″	122°–58′–00″

* Dredge time is considered as bottom time only.
Double line across chart indicates new trip to location.

COLLECTING STATIONS *(N. B. Scofield)*

Station No.	"N.B.S."* No.	Date	General Locality	Position	
				N. Lat.	W. Long
67		7/16/50	Northwest of Middle Farallon heading southeast		
68	1	10/2/50	Off Pescadero Creek on Rocky Reef		
69	2	10/3/50	Off Pescadero Creek between Point Ano Nuevo-Pigeon Point		
70	3	10/5/50	Drakes Bay; From SW. to NW.		
71	4	10/6/50	Off Big Flat		
72	5	10/6/50	Off Big Flat between Stillman and Big Creek; E. by S. ½ S.		
73	6	10/6/50	Off Big Flat; due west between Stillman and Big Creek		
74	7	10/6/50	Off Big Flat between Stillman and Big Creek; headed E. SE. ½ S.		

* Station numbers of the Division of Fish and Game M. V. *N. B. Scofield.*

COLLECTING STATIONS—(Data continued)

Depth in Fathoms	Duration of Haul*	Net Type	Bottom and Content
500–400		Two 1′ dredge and net combination	Fish, shrimp, Ctenophora, jellyfish
400–450		Two 1′ dredge and net	Mud; gastropods, shrimp, jellyfish, Ctenophora, fish
1150–1000		Two 1′ dredges	Rocks; mud; shells; coral tunicates, annelids, ophiuroids
25		Hook and line	Rockfish; observed 250; Steller sea lions
1100–1000	1230–1400	Two 1′ dredges	10 lbs. of rock and clay-like shale; Scyphozoa; crustaceans
850–700	1730–0400	Set line; night light dip nets	83 fish
6		Hook and line	Few starry flounder

COLLECTING STATIONS—(Data continued)

Depth in Fathoms	Duration of Haul	Net Type	Bottom and Content
70			Rocks, Bryozoa, corals, pelecypods, annelid tubes
13	1330–1630	Handline	3 cabezones
20	0730–1200	Handline	Flounder and rockfish
10–19	1000–1010	Beam trawl	Mud
15	0824–0915	Beam trawl	Gorgonias, crabs, flatfish
15–21	1030–1102	Beam trawl	Crabs, sole, skates, sand-dabs
35	1132–1216	Beam trawl	Box crabs and flatfish
60–64	1251–1330	Beam trawl	Box crabs, prawns, flatfish, nudibranch

COLLECTING STATIONS—(Continued)

Station No.	"N.B.S."* No.	Date	General Locality	Position	
				N. Lat.	W. Long
75	8	10/6/50	Delgada Canyon between Shelter Cove and Big Flats		
76	9	10/8/50	Off Humboldt Bay; west by north ½ north		
77	10	10/8/50	Off Humboldt Bay; west by north ½ north		
78	11	10/8/50	Off Humboldt Bar; north ¾ east		
79	12	10/8/50	West northwest of Eureka Bar		
80	13	10/8/50	Off North end of Humboldt Bay; southwest by south ¼ south		
81	14	10/8/50	Off north end Humboldt Bay; northeast ¾ west		
82	15	10/9/50	Approx. 10 miles north of Blunts Reef Lightship and north of False Cape		
83	16	10/9/50	West of Blunts Reef; west by north		
84	17	10/11/50	Off Punta Gorda in Mattole Canyon		
85	18	10/12/50	Approximately 10 miles southwest of Shelter Cove		
86	19	10/12/50	4 miles north of Fort Bragg; just south of Noyo Canyon		
87	20	10/12/50	Off Fort Bragg; south by ¾ east		
88	21	10/12/50	Off Fort Bragg; north northwest ¼ west		
89	22	10/13/50	Drakes Bay; east northeast ¼ east		
90	23	10/13/50	Drakes Bay, between Block 438 and 448		
91	24	10/13/50	Off Bolinas Bay, E. ½ N.		
92	25	10/13/50	Off Bolinas Bay, E. ½ N.		
93	26	10/15/50	Off Bolinas Bay from south end to Duxbury Reef and Double Point		
94	27	10/15/50	Drakes Bay, just north of Double Point		

* Station numbers of the Division of Fish and Game M. V. *N. B. Scofield.*

COLLECTING STATIONS—(Data continued)

Depth in Fathoms	Duration of Haul	Net Type	Bottom and Content
285–155	1438–1455	12″ round dredge	Many shells, brachiopods, mud
40–52	0915–0947	Beam trawl	Dover sole, echinoids, pectens, hermit crabs, shells
80–120	1013–1044	Beam trawl	Rockfish, octopus, hermit crabs
65	1200–1238	Beam trawl	Annelids, hermit crabs, starfish, heart urchins
68–75	1303–1336	Beam trawl	Heart urchins, flatfish
200	1422–1502	Beam trawl	Teredo logs, hermit crabs, shells
68–50	1527–1600	Beam trawl	Shells, hermit crabs, skates
40–44	0928–1000	Beam trawl	Box crabs, flatfish, ratfish
600	1303–1403	¼ meter tow net 1 meter tow net	Annelids and shrimp
300–100	1515–1615	12″ round dredge	Rocks, mud, shells, coral, shrimp, crabs, anemone, crinoids, Chaetognatha
85–92	0755–0840	Beam trawl	Brachiopods, urchins, starfish, ratfish, egg cases
85–88	1153–1238	Beam trawl	Sea urchins, octopus, annelids, pelecypods, caprellids
100–125	1318–1354	Beam trawl	Prawns, anemones, starfish, hermit crabs, urchins, fish
125–175	1453–1553	Beam trawl	Hermit crabs, sea urchins, flatfish
25–20	0737–0805	Beam trawl	Crabs and fish
15–22	0836–0855	Beam trawl and net # 769	Flatfish, skates, sand-dabs
12	1010–1105	Beam trawl	Sea cucumbers, starfish, sponges, rockfish, ocean perch
12	1023–1045	Beam trawl	Crabs, lingcod, rockfish, dog shark
7–17	0922–1312	Beam trawl and frame	Crabs, flatfish, skates, shark, sole
10–21	1342–1510	Beam trawl and frame	Net snagged; specimens lost

never fails to attract attention. A faultless explanation of their presence is difficult to find. One which perhaps has not received its full share of consideration is the possibility that they were dropped from floating ice during the glacial period. During parts of that period ice reached the sea from points as far south as the Olympic Mountains. There is no assurance that floating bergs reached the latitude of San Francisco but it is a possibility.

BIOLOGICAL RESULTS

Inevitably in such work as this much information and material of interest to biologists will be obtained. While the gear used in the present case was designed to secure rocks in considerable quantity, many living specimens dredged were preserved for study. Much of the sea bottom adjacent to continents is densely populated with animal life and rocks or other bottom material cannot be obtained without a representation of this fauna. Gear designed especially to secure it would be provided with means so that it would skim over the bottom and not cut down into it.

Important results from a biological standpoint will appear elsewhere, but a few observations which were made seem to be significant from a geological viewpoint.

It was expected that the very steep continental slope west of the Farallon Ridge would offer an ideal situation for the growth of bottom organisms. An upwelling from deeper waters might be present and in such places prolific growths have been observed elsewhere. We did not find this to be the case. The slope seems to be swept clean and is relatively barren so far as our dredge hauls offer an indication. In fact active erosion is in process.

One of the principal agents of erosion, perhaps the most important one, is the work of certain rock-boring worms. Several species of these are present but the most striking is the one which choses to bore into hard siliceous cherts and similar rocks. How they do this is unknown but a great many examples were collected which were fairly riddled with them. In some cases the penetration is fully two inches. Rarely did they attack the hard pebbles composed of quartzite or metavolcanic material and this may account for what seems to be the presence of such well rounded boulders in undue abundance; they may be residuals from submarine erosion.

In addition to these borings there were cavities which were practically certain to have been made by boring mollusks such as *Pholadidea.* These were found down to depths of 600 fathoms in some cases but no remains of shells were present. Such species normally live in intertidal areas or just below. Some geologists interpret ''pholad borings'' as definite evidence of shallow water conditions and unconformities. In this case, in the absence of a better interpretation, it seems that subsidence offers the best explanation.

There is additional evidence of relatively recent subsidence of a lesser magnitude. This consists of the presence of intertidal shells of *Mytilus californianus* at several places down to 50 fathoms. They were especially noticed around Cordell Bank which is 30 miles from the nearest shoreline. All which were recovered were very old "dead" shells but would not be classed as fossils.

Notes on the Geologically Significant Stations

The preceding list gives data on all stations occupied during this project. Many of them for various reasons are of no geological significance. Those which did furnish rocks or other noteworthy material are listed below with additional information derived from examination of hand specimens. Exact mineralogical determinations will be found in the report by Mr. Chesterman which follows.

2. N. Lat. 38°00′, W. Long. 123°22.4′, east side of Cordell Bank 16.75 mi. west of Point Reyes light, 57–50 fms.

This station furnished several hundred pounds of rocks, mostly large angular blocks of granodiorite broken from ledges. These, as well as smaller pieces, were encrusted with various organisms and showed evidence of fairly deep weathering. There were several pieces of pebble and boulder conglomerate and a large quantity of well-rounded pebbles and gravel probably derived from the same rock. Some of the boulders were six inches in diameter; most of them were a very hard dark metavolcanic rock which was not bored into by organisms and by hand lens examination showed little evidence of weathering.

7. N. Lat. 38°03.3′, W. Long. 123°31.2′, northwest side of Cordell Bank, 124–90 fms. The dredge secured about 25 pounds of pebbles up to four inches in diameter. Some of these were waxy quartzite, others a green metavolcanic rock. There were a few granitic fragments and pieces of pebbly conglomerate. Weathering was not obvious in hand specimens but many of the boulders and pebbles have innumerable incipient fractures which make them easy to crush with the hammer.

10. N. Lat. 38°02.2′, W. Long. 123°24.8′, Cordell Bank, 34 fms. About 100 pounds of granitic fragments. Most of these were heavily incrusted with organisms and some contained borings up to one inch in diameter. These holes are very old and are exactly like those made by mollusks such as *Pholadidea ovoidea* but in no case was there a trace of shell remaining. This, together with the presence of very old shells of *Mytilus californianus* in the same haul, indicates strongly that at no very distant date Cordell Bank was intertidal. There were a very few pebbles of dark colored rocks which presumably were derived from nearby conglomerate.

11. N. Lat. 37°59.2′, W. Long. 123°27.0′, Cordell Bank, 74 fms. Two dredge hauls were made at this station. In the first there were about 200 pounds of angular fragments of granitic rocks, deeply weathered but not rounded. A few pieces of schistose material were also obtained and some of these contain borings like those made by *Lithophaga*. The other haul contained about 100 pounds of nearly pure foraminifera. These appear to be living forms in the area and were not derived from a fossil bed. It is difficult to account for such a concentration.

12. N. Lat. 37°54′, W. Long. 123°25.7′, off Cordell Bank, 218–100 fms. About 75 pounds of hard, black, banded chert containing abundant cavities of fossil foraminifera. The dark color is due to petroleum residue. Such rocks are typical of the Monterey Miocene of California. In addition there was one large piece and some debris of a soft, gray silty shale which contain abundant beautifully preserved foraminifera and diatoms.

19. N. Lat. 37°55′15″, W. Long. 123°24′05″, Cordell Bank bears 347°T, 6.2 miles distant; 70 fms. About 1000 pounds of cherty Miocene shale and a few fragments of granitic rocks were obtained at this station. The chert is slightly silty and has been greatly bored to a depth of an inch by a species of worm which has not yet been identified. In addition there were numerous borings which were precisely like those made by shallow water mollusks such as *Pholadidea*.

20. N. Lat. 37°55′45″, W. Long. 123°19′15″, Cordell Bank bears 320°T, 8.2 mi. distant, 60 fms. The bottom at this point was a soft dark-colored sand with few organisms. The haul at this station consisted of only a few pounds.

22. N. Lat. 37°48′40″, W. Long. 123°23′00″, Fanny Shoals bear 90°T, 8 mi. distant, 400 fms. The dredge recovered about 100 pounds of soft silty fossiliferous sand containing many foraminifera and sponge spicules. The presence of a species of *Siphogeneroides* indicates that the age is Miocene, probably a part of the Monterey formation.

25. Pioneer Seamount. N. Lat. 37°22.8′, W. Long. 123°25.0′, 41 mi. southwest of San Francisco lightship, 480–450 fms. Many siliceous sponges, some of them 10 inches high, and all dead, were secured in this haul. In the mud among the sponge debris there were large numbers of living foraminifera. About 100 pounds of rocks was obtained. These rocks are mostly volcanic, some being highly altered, presumably by submarine weathering. In the cavities of some of the lavas there is a brilliant blue deposit, probably a phosphate mineral.

27. Pioneer Seamount. N. Lat. 37°24.4′, W. Long. 123°23.5′, 600–500 fms. About 25 pounds of dense black basalt was obtained here. Some pieces were 10 inches across. An altered zone about an inch deep covers each piece.

28. Pioneer Seamount. N. Lat. 37°21.0′, W. Long. 123°25.0′, 600–400 fms. Many siliceous sponges, all dead, were secured.

29. Pioneer Seamount, N. Lat. 37°21.0′, W. Long. 123°25.8′, 440–540 fms. About 200 pounds of vesicular basalt was obtained at this station. The original color was black but some large pieces have been altered and all or nearly all of the original mineral has been replaced. Some of the replacement, perhaps most is a phosphatic mineral and the color is changed to a light brown. Some very large pieces of siliceous sponges were attached to the blocks of basalt.

32. N. Lat. 37°26.5′, W. Long. 123°28.7′, "Mulberry" Seamount, 1000–700 fms. About 300 pounds of dense, black, vesicular basalt was obtained here. The cavities are lined with a secondary mineral, nearly white to bright blue.

34. N. Lat. 37°31.9′, W. Long. 123°2.8′, south of Farallon Islands, 320–250 fms. Recovered about 100 pounds of friable, dark gray siltstone. No fossils were seen in hand lens inspection.

35. N. Lat. 37°32.3′, W. Long. 123°2.7′, 340–120 fms. Hauled toward Point Montara. Only a small quantity of light gray silt was recovered.

36. N. Lat. 37°46.4′, W. Long. 123°00′, toward Sharps Park, 80–65 fms. A few small pieces of light gray sedimentary rock were obtained. These contained fossil foraminifera, very well preserved. With them there were several rounded pieces of granitic rock. In addition, the haul included about 200 pounds of friable dark gray silty mud; this last is firm enough so that it is believed to be older than Recent sediment but no fossils were found in it.

38. "Mulberry" Seamount. N. Lat. 37°26.5′, W. Long. 123°28.7′, 690–800 fms. About 200 pounds of highly vesicular, somewhat scoriaceous volcanic rock was obtained at this station. Weathering and alteration are not readily apparent. One large, erratic rock was dredged; it appears to be a highly altered piece of Monterey siliceous shale with large borings such as shallow water mollusks make.

45. N. Lat. 37°04′30″, W. Long. 123°04′30″, 600–400 fms., on the continental slope. Guide Seamount bears 256°T, 13 miles distant. About 500 pounds of dense phosphate rock and a smaller quantity of a highly altered, light colored, laminated shale like rock were recovered here. The phosphate rock is in the form of large flat masses with the rounded knobs. It contains bones of fishes, foraminifera, and diatoms.

50. N. Lat. 37°25′45″, W. Long. 122°55′, 16.5 mi. south of Farallon Islands, 200 fms. Besides some mud and silty sediment, the only rock obtained was a small piece of light gray, soft, siltstone without fossils.

51. Continuation of Station 50, 180–80 fms. About 1000 pounds of rather tightly cemented silty gray sand was taken. All pieces are highly bored by worms and the nestling mollusk *Saxicava* is common in some of the cavities.

54. N. Lat. 37°40′30″, W. Long. 123°03′50″, Farallon light bears 240T°, 3.5 mi., 45–55 fms. A few small pieces of crystalline rocks were recovered;

these are unlike the granitic rocks of the Farallon Islands but are insufficient to be diagnostic.

56. N. Lat. 38°03′50″, W. Long. 123°33′30″, northwest of Cordell Bank, 400–200 fms. About 800 pounds of black or dark brown rock was dredged. The pieces are two to eight inches across and all appear to be more or less pure phosphatic material. The percentage of sand is very low. Along with this material there was a quantity of pebbles of various composition having a total weight of about 25 pounds. These did not differ especially from those found on the east side of Cordell Bank.

62. N. Lat. 37°42′30″, W. Long. 103°23′, south of Farallon Islands, 1150–1000 fms. This station furnished about 100 pounds of siliceous shale, and some coarse pebbly sandstone. In addition there was about 20 pounds of friable gray silty shale with abundant Miocene diatoms and foraminifera.

64. N. Lat. 37°33′, W. Long. 123°15′, 10 mi. east of ''Mulberry'' Seamount, 1100–1000 fms. A few pieces of friable, light gray, silty shale were obtained.

67. Northwest of Middle Farallon Island in 70 fms., secured by the Fish and Game vessel, *N. B. Scofield,* July 16, 1950. About 100 pounds of siliceous chert, very greatly bored by worms, was recovered. This material, inside of the altered surface layer resembles much of the Miocene chert of continental areas.

75. Delgada submarine canyon off Buck Creek, Humboldt County, California, 285–155 fms. N. B. S. No. B. 8, Oct. 6, 1950. The haul consisted of a few pounds of friable gray siltstone greatly perforated by boring organisms and a few pebbles of very hard dark gray sedimentary rock. No fossils were found in the siltstone and all that can be determined at present regarding its age or relationship is that lithologically it is very similar to much of the Pliocene found in Humboldt County.

77. Off Eureka Bar, Humboldt County, California, 80–120 fms. N. B. S. Nos. 3, 10, Oct. 8, 1950. A few pounds of typical Wildcat formation, gray siltstone, was obtained. *Pecten caurinus* and other fossils were present.

84. South side of Mattole Canyon, Humboldt County, California, 300–100 fms., Oct. 11, 1950. N. B. S. No. B. 17. About 100 pounds of rocks, mostly well rounded pebbles up to three inches across, were taken at this station. All of these which were examined were formed from hard sedimentary rocks, such as are found on the adjacent mainland. Some of these hard rocks, even well cemented sandstones, have been greatly perforated by boring worms. It was hoped that this station would furnish some clue as to the nature of the great submarine cliff which extends west from Punta Gorda but the only other material in the dredge which was significant in this connection was a quantity of dead calcareous algal stems, which resemble some forms of coral.

Notes on Gear

The U. S. S. *Mulberry* was equipped with adequate power to handle gear of almost any capacity which might be devised. The drums on the winches were of large size and in the regular work of the ship these are spooled with wire line .75″ to 1.50″ in diameter. We made a few hauls with the smaller size but most of the work was done with .375″ wire line which was supplied by the Bureau of Ships from the Navy Yard at Mare Island. Each drum carried enough so that there was no difficulty in reaching bottom in 2000 fathoms. An "A" frame was rigged aft to carry the line above deck.

Several designs of heavy, square and rectangular dredges were tried out but did not dig in among rocks as much as was desired. We, therefore, adopted a dredge which was circular in cross section. The mouth was made of a piece of pipe 18″ or 12″ in diameter and 18″ or 12″ long. The bridle was shackled to this and four .50″ rods were welded over the aperture as a protector. On the back of this piece of tubing either heavy screen wire or expanded metal lath was welded, forming a cylinder about four feet long for the smaller size and six feet long for the larger one. This screen was protected by four rods welded to the pipe. Sometimes a liner of fine wire was put inside of the coarse mesh.

This makes an exceedingly rugged dredge, essentially a "drag line" in commercial practice. Some were lost but in no case was this the result of fouling on bottom. Rocks weighing more than a hundred pounds were broken off of ledges occasionally.

Undoubtedly the ideal dredge for such work would be some sort of clam shell of half a yard capacity or more. With this a sample could be obtained from a single spot whereas with a drag line more or less of the area must necessarily be covered. Thus a mixture of materials is obtained, depending upon length of drag, steepness and direction of slope, and other factors, most of which are beyond the control of the operator. The chief objection to a clam shell is the difficulty of handling it aboard ship, especially in rough weather.

When opportunity offered we used tow nets effectively and sometimes shackled them to the dredge line. Thus a considerable amount of pelagic animal life was obtained, incidental to the main objective.

Very little effort was spent in attempting to get core samples and these were unsuccessful. It was believed that such an operation would take too much time, if carried out systematically, to make it worthwhile. As it turned out, the steepness of the continental slope and presence of outcropping rocks on it probably would have prevented very satisfactory results with a core barrel.

Various forms of strain indicators were used on the dredge line but none of them, in our opinion, were as effective as the simple device originated by Mr. W. E. Ripley of the California Division of Fish and Game. This consists merely of an ordinary spring balance such as is used for weighing fishes. It is fastened to some part of the ship by one end and the other is hooked over the dredge line with a running sheave. A positive strain is put on the scale before the gear reaches bottom. Subsequently any additional strain shows on the dial.

EXPLANATION OF PLATES

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Southeast Farallon Island showing the terrace upon which the lighthouse maintenance buildings are placed and in the foreground, sea caves made during a former submergence. The highly weathered and fractured nature of the diorite is visible in the original print. The camera was pointed westerly. U. S. Coast Guard photo No. 6,164,917, June, 1949, received from Mr. G. E. Logan.

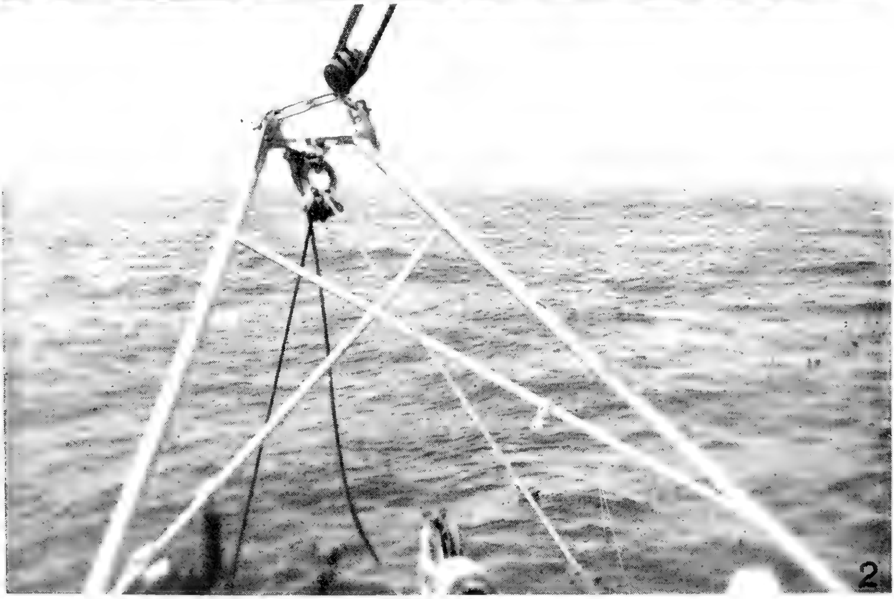

Figure 1. North Farallon Rocks as seen from the northeast. There are five main rocks and several smaller ones.

Figure 2. "A" frame mounted aft on the U. S. S. *Mulberry* for dredging and trawling. This equipment worked satisfactorily in depths as great as 2000 fathoms.

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Figure 1. The after winches of the U. S. S. *Mulberry*.
Figure 2. Rigging a tow net to attach to the dredge line on the U. S. S. *Mulberry*.

Figure 1. Dumping a heavy dredge load of rocks obtained on the continental slope, Sta. 56 in 200–400 fms., northwest of Cordell Bank.

Figure 2. Miocene chert, greatly bored by worms, from the continental slope, Sta. 12, in 100–218 fms., Cordell Bank, 3.75 miles, bearing 14° True. Dr. R. C. Miller examining material brought up in the dredge.

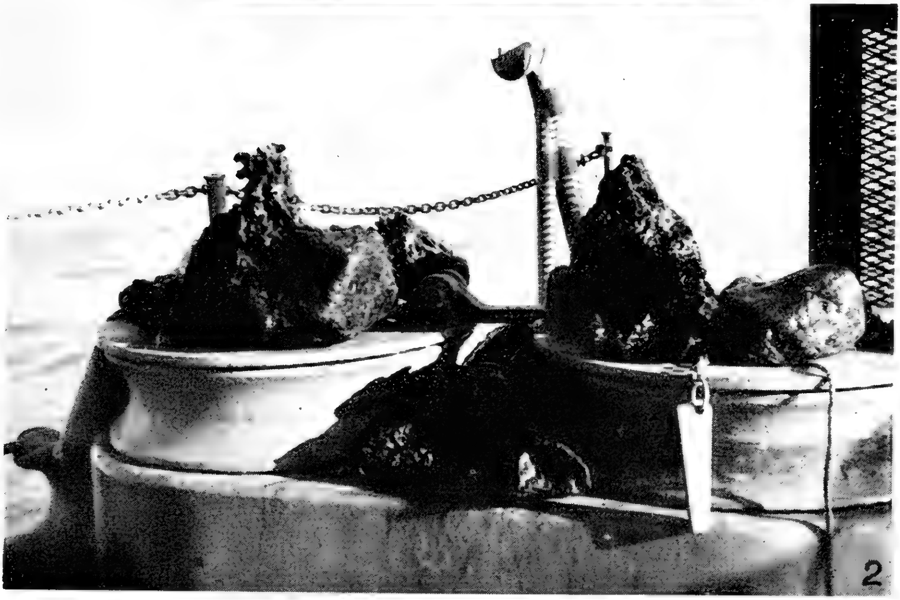

Figure 1. A large piece of Miocene chert greatly bored by marine organisms, mostly worms. The pencil shows the scale. From 70 fms., northwest of Middle Farallon Island July 16, 1950, Fish and Game vessel *N. B. Scofield*.

Figure 2. Representative volcanic rocks from Pioneer Seamount, a siliceous sponge (dead) attached to the rock on the left. Sta. 29, 440–540 fms.

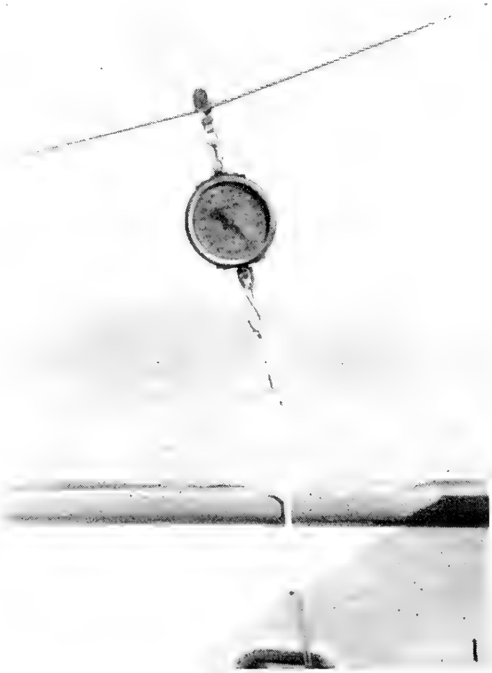

Figure 1. A simple spring balance as used for a strain indicator on the trawl line by Wm. Ripley and associates on the Fish and Game vessel *N. B. Scofield.*

Figure 2. Launching the beam trawl from the deck of the *N. B. Scofield.*

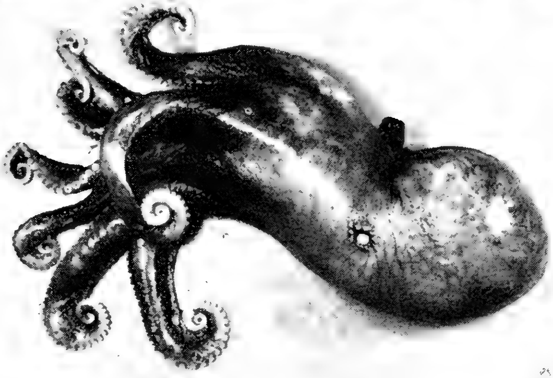

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Figure 1. W. I. Follett and Robert Dempster, preparing biological specimens obtained at Cordell Bank by U. S. S. *Mulberry.*

Figure 2. A rare pelagic octopus, *Japetella heathi* (Berry) from Sta. 155 in 700–820 fms., off North Farallon Islands, Nov. 12, 1950, *N. B. Scofield*, No. 50–B–88. This group of cephalopods has only one row of suckers on the arms, whereas the ordinary octopus has two. The species has not been illustrated heretofore. Length as photographed, 235 mm.

Figure 1. Dumping a heavy dredge load of rocks obtained on the continental slope by U. S. S. *Mulberry*.

Figure 2. A group of Pliocene fossil shells (Wildcat formation), *Compsomyax* and *Pecten caurinus* Gould, Hypotype No. 4284 (Calif. Acad. Sci. Dept. Paleo. Type Coll.), collected by Captain V. Niemi of the fishing boat *Ina* from Loc. 33223 (C. A. S.) from S. W. of Trinidad Head, California, in 96 fathoms. Many similar specimens were dredged off Eureka, Humboldt County, California, as far as 30 miles and as deep as 80–120 fms. (Sta. 77) by the Fish and Game vessel, *N. B. Scofield*, October 8, 1950.

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DESCRIPTIVE PETROGRAPHY OF ROCKS DREDGED OFF THE COAST OF CENTRAL CALIFORNIA

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INTRODUCTION

Several different kinds of igneous and sedimentary rocks were collected by the California Academy of Sciences while investigating the geology of the continental slope off the coast of central California. By far the largest number consisted of fine-grained fossiliferous siltstones which contain both diatoms and foraminifera. The next most abundant were the volcanic rocks, mainly rhyolite, andesite, and basalt. Quartz diorite was the only plutonic rock collected and it constituted only a minor part of the many samples obtained during the course of the investigation. Representative material was chosen from the various stations and the following report is the result of study of thin sections as well as hand specimens. Localities are recorded by station number, the details of which may be found on pp. 334–343 of the preceding report by G D. Hanna (1952).

There were essentially four kinds of sedimentary rocks collected. They are fossiliferous siltstones, sandstones, phosphorites, and tuffs. Siltstones were collected at stations 7, 14, 19, 25, 38, 51, 54, 56, 62, and 64; sandstone at stations 2 and 11; phosphorites at stations 12, 25, 45, 56, and 62; and tuff at stations 2, 25, and 29. Several of the siltstone samples collected at stations other than those listed for phosphorites, are slightly phosphatic, but not sufficiently to be classed with the phosphorites.

The plutonic rocks are very uniform in character and composition. They are biotite-quartz diorite and were collected at stations 2, 7, 10, 32, and 54. There is, however, considerable variation in the types of volcanic rocks collected, both as to composition and texture. Basalt samples were collected at stations 25, 27, 29, 32, and 38; andesites at stations 2 and 7; and rhyolites at station 5 only.

The phosphorites and phosphatized sedimentary and volcanic rocks are of considerable interest, especially economic interest. Not only have some of the siltstones been more or less completely phosphatized, but several specimens of tuff and basalt have also been partly phosphatized. One specimen of basalt (station 29) is phosphatic to a depth of ⅛ inch. The interior of the same specimen is slightly phosphatic, but not anywhere as much as the rim. Specimens of tuff and tuff breccia from stations 2 and 25 have been partly phosphatized.

A study of the phosphorites and partly phosphatized rocks indicates somewhat the extent to which phosphatization has taken place, but does not indicate the lateral extent of the process nor the size and shape of the phosphate bodies. The latter, however, can only be determined through careful and systematic sampling of those areas where phosphorites and phosphatized rocks were found.

PLUTONIC ROCK

Biotite-Quartz Diorite: The biotite-quartz diorite is typically coarse-grained, equigranular, massive, and slightly gneissoid. Few of the specimens showed minor amounts of brecciation. On the weathered surface, the rock is unequally colored with limonite. Quartz and plagioclase are the essential minerals. Biotite is present in all specimens, whereas hornblende occurs only sporadically. The quartz is glassy and the feldspar is dull white.

Microscopical Characteristics: Under the microscope the biotite-quartz diorite has a hypiodiomorphic-granular texture. The grain size ranges from 1 to 5 mm. for plagioclase; 1 to 2 mm. for quartz; and up to 3 m. for biotite. The plagioclase ranges in composition from basic oligoclase (An_{25}) to acid andesine (An_{35}). It occurs in subhedral crystals and irregularly shaped grains showing well developed albite and carlsbad twinning and poorly developed pericline twinning. Zoning is not common, though present in the quartz diorite from station 25. Alteration to kaolin and calcite is common, more so at the interior of the crystals than the exterior. Both orthoclase and microcline are present in limited amounts, especially in the form of anhedral crystals which have been more or less altered to kaolin and sericite.

Quartz, on the other hand, generally appears as glassy and slightly clouded anhedra. In a few specimens it shows strain shadows and contains numerous curving hairlines of sub-microscopic, black inclusions.

Although both biotite and hornblende are present, biotite is the commonest ferromagnesian mineral in the rock. It usually occurs in dark brown pleochroic plates and irregular crystals. Alteration to dark green chlorite is common, especially at stations 7 and 25. Hornblende is in dark green, pleochroic, subhedral crystals. They are also partly altered to chlorite.

Sphene, zircon, apatite, and magnetite occur sporadically as inclusions in the other minerals.

In so far as mineral composition is concerned, the biotite-quartz diorite contains, on the average, the following:

Plagioclase	40 to 60 per cent
Quartz	35 to 50 per cent
Biotite	5 to 10 per cent

The biotite-quartz diorite collected in the deep waters off the coast of central California very closely resembles the quartz diorite exposed on south Farallon Islands (Hanna, 1951) and along the coast from Montara Mountain (Lawson, 1895) to Point Sur (Trask, 1927, and Reiche, 1937).

VOLCANIC ROCKS

Three kinds of volcanic rocks were collected and examined microscopically. They are, rhyolite, andesite, and basalt. There is far more variation in the basalts than either the rhyolites and andesites. Some of the basalts contain olivine while others are devoid of this mineral. Also, there appears to be a wider distribution of basalt as indicated by the amount of this material collected at the various stations.

Rhyolite: Rhyolites were collected only at station 25. In hand specimen, the rhyolite is a dense, hard, fine-grained porphyritic rock varying in color from medium gray, through dark brownish-gray to chocolate brown.

Microscopical Characteristics: Under the microscope they are porphyritic in which phenocrysts of quartz, orthoclase, and plagioclase are enclosed in a microcrystalline groundmass of partly devitrified glass. In several of the specimens showing less devitrification, fluidal banding and flow lines are distinctly visible. Sanidine is the potash feldspar. An occasional angular crystal of anorthoclase can be found. The sanidine normally occurs in euhedral and subhedral crystals with or without carlsbad twinning. Alteration to kaolin is common, especially along fractures. Some of the fractures in a few of the more altered phenocrysts are filled with an aggregate of small quartz grains, apparently secondary.

Quartz is an abundant mineral, and occurs in the groundmass and as anhedral crystals and corroded grains. It is glassy in appearance and oftentimes shows strain shadows.

TABLE 1

Areal Distribution of Rock Types Examined Microscopically

Station	Plutonic Rock	Rhyolite	Andesite	Basalt	Siltstone	Sandstone	Phosphorite	Pyroclastic
2	3	5	3	.	.	1	.	1
7	1	.	1	.	2	.	.	.
10	2	.	.	.	.	.	.	.
11	.	.	.	.	.	2	.	.
12	.	.	.	.	.	.	3	.
14	.	.	.	.	3	.	.	.
19	.	.	.	.	1	.	.	.
25	.	.	.	2	1	.	.	2
27	.	.	.	1	.	.	.	.
29	.	.	.	1	.	.	.	1
32	1	.	.	4	.	.	.	.
38	.	.	.	1	1	.	.	.
45	.	.	.	.	.	.	3	.
51	.	.	.	.	1	.	.	.
54	1	.	.	.	2	.	.	.
56	.	.	.	.	4	.	2	.
62	.	.	.	.	8	.	1	.
64	.	.	.	.	4	.	.	.
Totals	8	5	4	9	27	3	9	4

STATIONS FROM WHICH SAMPLES WERE SELECTED FOR DETAILED STUDY*

Sta. No.	Depth fathoms	Nature of specimens
2	57–50	3 in place, 10 pebbles
7	124–90	1 in place, 3 pebbles
10	34	2 in place
11	74	2 pebbles
12	218–100	3 phosphorite
14	126–70	3 erratic
19	68–70	1 in place
25	480–450	2 in place, 3 perhaps erratic
27	600–500	1 in place
29	440–540	2 in place
32	1000–700	4 in place, 1 erratic
38	690–800	1 in place, 1 erratic (?)
45	600–400	3 phosphorite
51	180–80	1 in place
54	45–55	2 in place, 1 erratic
56	400–200	6 in place
62	1150–1000	9 in place
64	1100–1000	4 in place

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* In this table an attempt has been made to indicate whether the material was in place on the sea bottom, but obviously this is often uncertain.

The plagioclase varies in composition from acid to basic oligoclase (An_{15} to An_{25}). It usually occurs in subhedral crystals showing both carlsbad and albite twinning. An occasional crystal showing pericline twinning is present. Alteration to kaolin is more pronounced in some rocks than in others.

Biotite is the only ferromagnesian mineral present in the rhyolites. It occurs in subhedral crystals which show, in some sections, considerable alteration. The unaltered biotite is dark greenish-brown and strongly pleochroic. In several sections the biotite has been altered to pale green chlorite. In the outer part of each altered biotite crystal one can find a narrow black zone of magnetite.

For the most part, the groundmass is composed of a partly devitrified glass, dark to medium-brown in color. Flow banding and fluidal structures are still evident. (See plate 15.) In one section, the glass is completely devitrified and consists almost wholly of a microcrystalline aggregate of quartz and feldspar grains so arranged as to indicate the original flow banding.

Andesite: Four specimens of andesite were collected from stations 2 and 7. In hand specimen, they range in color from dark greenish-gray to dark greenish-brown. The andesite, in general, is a hard, fine-grained, porphyritic rock containing distinct crystals of dull white feldspar firmly held in a fine-grained, semi-glassy groundmass. Ratio of groundmass to phenocrysts is approximately 10 to 1.

Microscopical Characteristics: The rock has a well developed porphyritic texture which shows phenocrysts of plagioclase and orthoclase set in a semi-crystalline groundmass. One specimen from station 2 is somewhat fragmental and appears to be an andesite breccia. The plagioclase is variable in composition, ranging from acid to intermediate andesine (An_{35} to An_{40}). It generally occurs as euhedral crystals, occasionally as subhedral and anhedral crystals. Albite, carlsbad, and pericline twinning are common. Inclusions of glass, sphene, epidote, and even chlorite are present in the plagioclase. Calcite and kaolin are the two alteration products, but a few crystals of basic oligoclase were found partly altered to epidote.

The groundmass plagioclase is usually in the form of untwinned microlitic laths scattered at random throughout the sections.

Orthoclase, when present, is in the form of subhedral crystals partly altered to kaolin and sericite.

Quartz is present in only those andesites collected at stations 2 and 7. It occurs, however, in small amounts, usually in well rounded grains and in fine-granular aggregates, especially in those areas where the groundmass glass has been most thoroughly devitrified. All ferromagnesian minerals, including hornblende and augite, have been completely altered to epidote and chlorite.

For the most part, the groundmass consists essentially of more or less completely devitrified glass which still retains some of its original fluidal structures. Secondary minerals include: epidote, chlorite, calcite, limonite, kaolin, and sericite.

Basalt: Of all the volcanic rocks collected, basalt is by far the most widespread in distribution. It was collected at five separate stations, two of which are Pioneer and Mulberry Seamounts.

In hand specimen the basalt is vesicular, black to grayish-black in color, fine-granular, and porphyritic. The feldspar phenocrysts are dark and glassy, while the olivine phenocrysts are dark green and the augite black. The vesicles are either filled or empty. The filling is chalcedony, chloropal, and calcite.

Microscopical Characteristics: Under the microscope the basalts have a porphyritic and sub-ophitic texture in which phenocrysts of feldspar are enclosed in a groundmass of lath-shaped feldspar and intersertal augite. Basic glass is rare, though often very dark due to the presence of dusty magnetite.

The essential minerals are basic plagioclase and augite. The plagioclase ranges in composition from intermediate to basic labradorite (An_{60} to An_{70}). The feldspar phenocrysts are more basic than the feldspar in the groundmass. Both carlsbad and albite twinning are common, and zonal structures are found, especially in the euhedral phenocrysts. Inclusions of dark brown glass are common. Few of the crystals are altered to calcite and kaolin. The phenocrysts are much more altered than the groundmass laths.

The clinopyroxene is augite. At stations 25, 32, and 38, basalt specimens were collected which contain titaniferous augite. In all cases, however, the augite is in the form of euhedral and subhedral crystals, both occurring as phenocrysts and as intersertal grains between the feldspar laths.

The titaniferous augite is pale violet in color and exhibits very strong dispersion. Although usually quite fresh in most rocks and sections, several sections showed it as having been altered in part to pale green chlorite with separation of magnetite (see plate 16 which shows a euhedral crystal of titaniferous augite rimmed with pale-green chlorite speckled with cubes and octahedra of magnetite). Other augite is colorless, and, too, has been altered partly to chlorite and almost colorless serpentine.

Olivine is not present in all basalts. When present, however, it is more or less completely altered to pale green serpentine and golden-yellow iddingsite. The unaltered olivine occurs in euhedral crystals showing prismatic faces and pyramidal terminations. Few of them have corroded borders. Inclusions of chromite are common, especially in the serpentinized crystals.

In addition to plagioclase and augite as groundmass constituents, there is also some dark brown glass which derives its dark color from black, dusty particles of magnetite.

Secondary minerals include: serpentine, iddingsite, chlorite, calcite, kaolin, limonite, chalcedony, and chloropal.

SEDIMENTARY ROCKS

Sedimentary rocks of various types were collected from 15 stations (2, 7, 11, 12, 14, 19, 25, 29, 38, 45, 51, 54, 56, 62, and 64). They include siltstone (fossiliferous and non-fossiliferous), sandstone, phosphorite, and tuff. To further classify them according to mode of origin, the siltstones and sandstones are clastic; the phosphorites are chemical, and the tuffs and tuff breccia are pyroclastic. The phosphorites and phosphatized rocks are perhaps of much more interest than any other sedimentary rock.

CLASTIC

Siltstone: In general, the siltstones are very fine-grained, buff to gray colored rocks. Bedding is poorly developed, and only visible in one or two specimens. They all contain circular conical holes, caused by marine boring organisms. All of the siltstones sectioned are hard and firmly cemented with silica and calcium carbonate. Some of them are fossiliferous and contain tests of diatoms and foraminifera. Specimens collected from stations 25, 51, and 62 are slightly tuffaceous and contain small angular fragments of pumice as well as glass shards.

Microscopical Characteristics: Under the microscope, the siltstones appear to range from massive siliceous shales to ordinary siltstones. They are all very fine-grained and appear to consist of angular grains of quartz, orthoclase, oligoclase, biotite, and pumice fragments enclosed in a much finer grained groundmass of silica, calcite, and clay particles. As previously stated, bedding is poorly developed. Scattered indiscriminately throughout the rocks are ovid-shaped bodies of emerald green mineral which resembles glauconite, but owing to its much weaker pleochroims it is tentatively called chamosite. Present in these green bodies are black cubic crystals of magnetite.

An occasional plate of pale green chlorite can be found. The pumice fragments and the glass shards have been largely devitrified and now present a characteristic salt and pepper effect. Specimens collected from stations 7, 14, 51, 56, 62, and 64 show some degree of phosphatization. The phosphatic material is yellowish to deep yellow-brown in color. It is isotropic and traversed by numerous conchoidal fractures. The phosphatic material is not evenly distributed throughout the rock, but seemingly localized in irregular patches where it acts somewhat as a cementing material for the detrital grains. In a few of the sections, there occurs a narrow, dark brown rim immediately surrounding the mineral grain which is enclosed in the phosphatic material. Also, in some of the tuffaceous siltstones, the pumice fragments are more or less completely changed over to the phosphatic material.

Scattered throughout the siltstones are tests of diatoms and foraminifera. The foraminifera tests are composed largely of calcite, while the diatoms are chalcedony. Some of the foraminifera have been partly phosphatized.

The groundmass, for the most part, is a mixture of chalcedony, calcite, and clay. Several of them contain more calcite than others, while some are rich in clay and chalcedony.

Sandstone: Sandstone specimens were collected at stations 2 and 11. The specimen from station 2 is a brecciated, gray, hard, firmly cemented sandstone made up of angular grains of quartz and feldspar firmly held in a chalcedonic-silica cement. The grains range in size from .5 mm to 2 mm. Specimens from station 11 are slightly finer grained than those from station 2. They, too, are gray in color and contain, besides quartz and feldspar, considerable dark brown biotite. The grains range in size from .5 mm. to 1 mm.

Microscopical Characteristics: Under the microscope the sandstones appear to be composed of rounded and angular grains of quartz, basic andesine, orthoclase, dark brown biotite, and muscovite set in a silica matrix. The feldspar is partly altered to kaolin and sericite and the biotite to dark green chlorite. The quartz occurs commonly in rounded and angular grains. Many of them are fractured and recemented with calcite and chalcedony. The brecciated sandstone from station 2 contains the following mineral composition:

Quartz	35 to 45 per cent
Andesine	25 to 30 per cent
Orthoclase	5 to 10 per cent

CHEMICAL SEDIMENTARY ROCKS

Phosphorite: Most of the phosphorite specimens are either dark chocolate brown or brownish-gray in color. They were collected from stations 12, 45, 56, and 62, along with other phosphatized siltstones. They all contain angular and rounded mineral grains. Some grains are glassy, others dull, but a majority of them are well rounded, especially the dull ones. Rock fragments, too, are present in limited amounts. Several specimens of phosphatized siltstone from stations 56 and 62 were found to contain 50 per cent or more phosphatic material. Their grain size is quite small, and they contain, in addition to quartz and feldspar, angular fragments of andesite and tests of diatoms and foraminifera which, too, have been largely phosphatized.

Microscopical Characteristics: Microscopically, the phosphorites and phosphatized siltstones vary considerably in mineralogical composition and texture. The phosphorites from station 56 consist of pellet phosphorite, phosphatic material, oolites, and detrital grains of quartz, feldspar, biotite, and oval-shaped grains of chamosite. In all the phosphorites, the oolites and pellets are somewhat widely separated (see plate 19, figure 2). Some of the pellets and oolites have neuclei of phosphatic material or a grain of quartz or feldspar. Wherever a concentric structure exists, it is usually confined to the exterior of the oolite. In a few places the chamosite surrounds and partly fills cavities in some of the pellets of phosphorite. The phosphatic material is largely collophane with a refractive index of 1.610. It is isotropic and ranges in color from yellowish to yellow-brown.

PYROCLASTIC ROCKS

Rhyolite Tuff Breccia: This is a dense, fairly hard, fine-grained fragmental rock. It is dark gray in color and consists of angular fragments of quartz, feldspar, pumice, and rhyolite firmly cemented in a dense, dark greenish-gray, fine-grained groundmass. The mineral grains range in size from .5 mm. to 2 mm.

Microscopical Characteristics: Under the microscope one can easily recognize the fragmental nature of the rock. It contains angular grains of orthoclase, plagioclase, quartz, pumice, and rhyolite firmly held in a groundmass of devitrified glass. The orthoclase is more or less altered to kaolin. It shows a well developed carlsbad twin in those grains which are incompletely altered. The plagioclase, too, is very highly altered to kaolin, but still one can make out the albite and carlsbad twinning. Although no definite composition can be assigned to the plagioclase, it appears to lie near intermediate oligoclase. Quartz is glassy, and occurs as angular and rounded grains, and as granular intergrowths with feldspar.

The groundmass is a fine-grained, devitrified glass which contains angular fragments of pumice and rhyolite. Flow banding may still be seen in those places where devitrification is less complete.

Among the secondary minerals, chlorite and kaolin are very common. The chlorite is pale green in color and exhibits beautiful ultra-blue and violet interference colors.

Basic Tuff: This is a fragmental rock with a mottled, grayish-brown color. On the weathered surface it is light brown in color. It contains angular fragments of pumice, minerals, and basalt held in a fine-grained, dark brown groundmass. The mineral fragments range in size from 1 mm. to 8 mm. The rock fragments are somewhat larger.

Microscopical Characteristics: The rock is decidedly fragmental, and is composed of angular fragments of plagioclase, augite, and basalt firmly held in a groundmass of phosphatized basic glass. The plagioclase ranges in composition from basic andesine (An_{45}) to acid labradorite (An_{50}), and occurs in partly altered, rounded and angular grains. Both carlsbad and albite twinning are common.

Augite is another common mineral. It is either colorless or pale pinkish, and occurs in rounded or subhedral grains. Alteration to chlorite is rare. However, one can find several angular and rounded grains surrounded by a narrow rim of dark brown phosphatic material (see plate 19, figure 1). In addition, an occasional feldspar grain and even small fragments of basalt have rims of phosphatic material. The degree of phosphatization was probably more intense in the case of this tuff than in some of the siltstones. Not only are the basalt fragments surrounded by a phosphatic rim, but the process went so far as to destroy the glassy groundmass in the basalt. Besides the phosphatic material, there are several round grains of emerald-green chamosite enclosing cubes and octahedra of magnetite.

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EXPLANATION OF PLATES

PLATE 15

Figure 1. Rhyolite. Showing subhedral crystal of sanidine (F) and a rounded grain of quartz (Q) held in a groundmass of partly devitrified glass (Gl.). Note fluidal banding and structures. From station 2. Magnification 70X. Plain light.

Figure 2. Basalt. Phenocryst of titaniferous augite (A) surrounded by rim of chlorite speckled with black magnetite and labradorite (F) enclosed in a dark groundmass of basic glass. From station 25. Magnification 70X. Plain light.

PLATE 16

Figure 1. Basalt, showing large subhedral phenocryst of titaniferous augite (A) surrounded by euhedral laths of labradorite. All enclosed in a groundmass of dark basic glass. From station 25. Magnification 70X. Plain light.

Figure 2. Slightly phosphatized fossiliferous siltstone, showing foraminifera and diatoms enclosed in a fine-grained groundmass of chalcedony, calcite, clay, and collophane. Dark coloration due to limonite. From station 45. Magnification 70X. Plain light.

PLATE 17

Figure 1. Fossiliferous siltstone, showing diatoms enclosed in a fine-grained matrix of clay, chalcedony, and calcite. Minor amounts of quarts and feldspar are also present. From station 64. Magnification 70X. Plain light.

Figure 2. Phosphatized siltstone, showing angular grains of quartz (Q), orthoclase (F), and pumice (Pu) inclosed in a phosphatized (Po) groundmass which consists almost wholly of collophane. From station 45. Magnification 70X. Plain light.

PLATE 18

Figure 1. Phosphorite. Angular and rounded grains of orthoclase (F) and quartz (Q) are surrounded by phosphatic material (Po). Note concentric structure in oolite. All dark borders are phosphatic material. Groundmass is essentially collophane. From station 56. Magnification 70X. Plain light.

Figure 2. Collophane. Phosphatized bone from station 56. Magnification 70X. Plain light.

PLATE 19

Figure 1. Phosphatized basic tuff. Note dark border of phosphatic material surrounding euhedral crystals of augite (A) and angular grains of feldspar (F). Groundmass is largely phosphatized basic glass. From station 25. Magnification 70X. Plain light.

Figure 2. Phosphorite. Angular and rounded grains of orthoclase (F), quartz (Q), and pumice (Pu) are surrounded by phosphatic material (Po). Concentric structure is well shown in several grains. Groundmass is essentially phosphorite. From station 56. Magnification 20X. Plain light.

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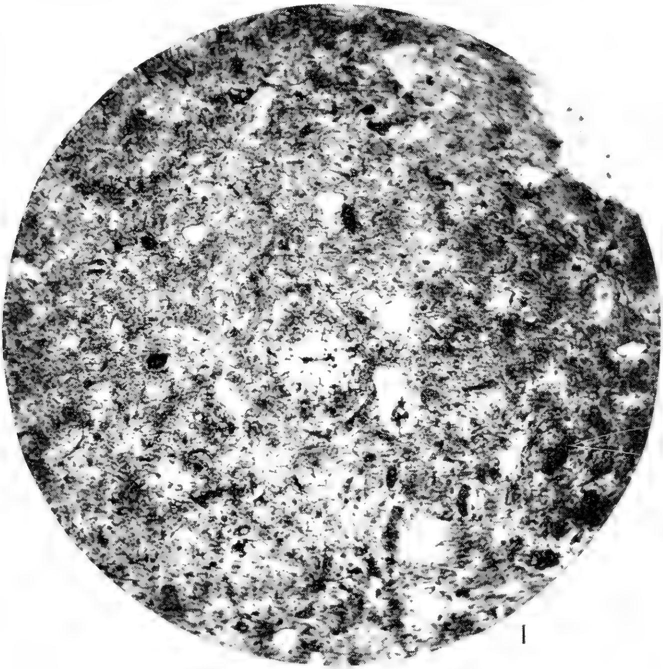

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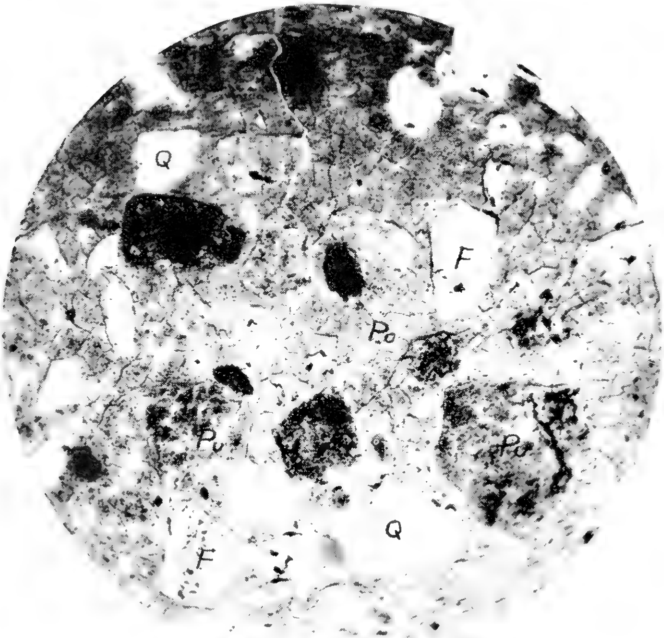

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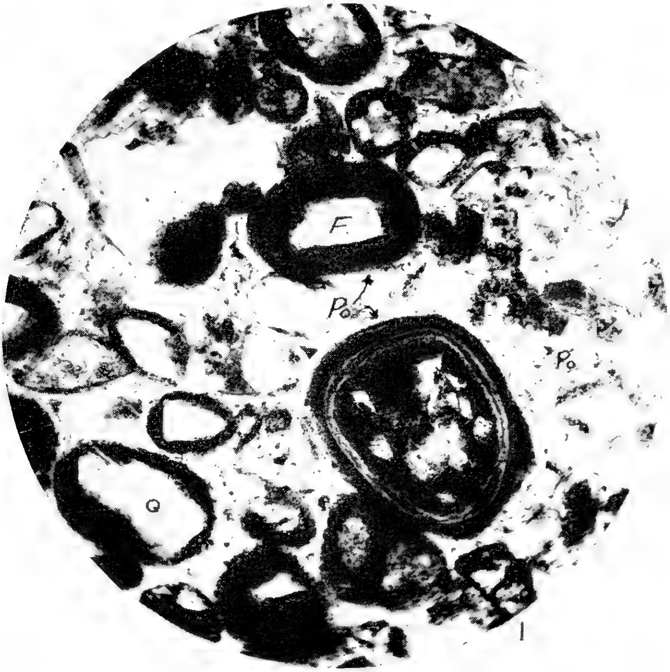
F
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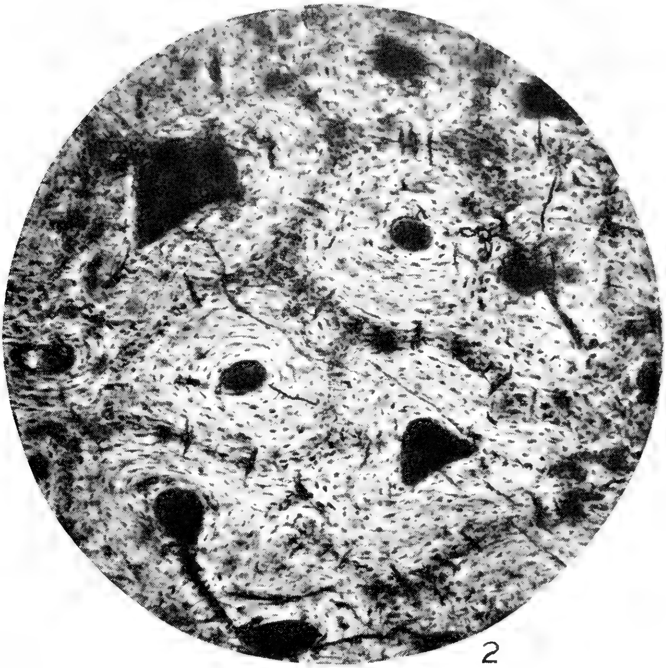
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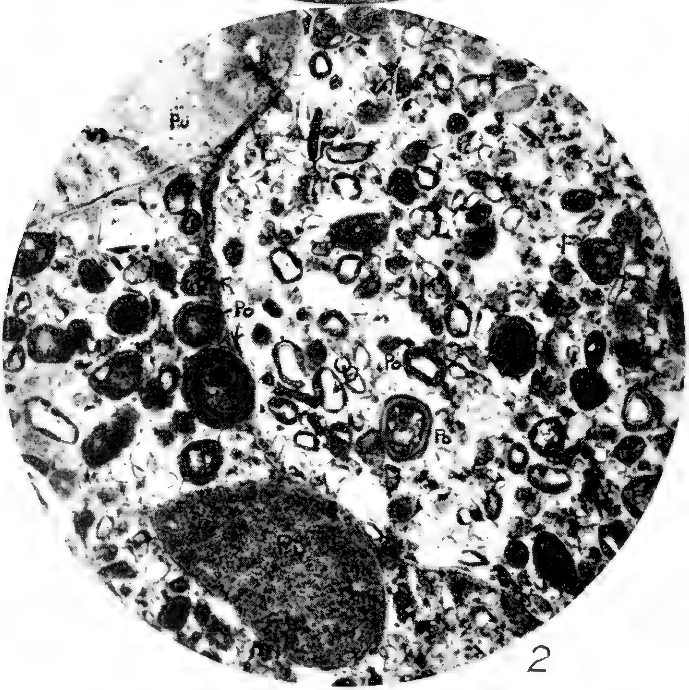

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PROCEEDINGS

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Vol. XXVII, No. 11, pp. 375–376, pl. 20, figs. 1, 5, and 8 July 11, 1952

A NEW SPECIES OF FORAMINIFERA OF THE GENUS *DISCORBIS* DREDGED OFF THE COAST OF CALIFORNIA

BY

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In conducting the geological work in connection with Contract No. N9 onr 94400 of the Office of Naval Research, by the Academy some very interesting lots of Foraminifera were collected and preserved. Dr. G D. Hanna, who was in charge of much of the field work, made a dredge haul off Shelter Cove, Mendocino County, California, which contained the original lot of a species of *Discorbis* which is believed to be undescribed.

Discorbis laquei Church, new species

Plate 20, figures 1, 5, and 8

Test trochoid; keel rounded, eroded; spire low, conical; dorsal side convex, ventral side concave, chambers numerous, flattened dorsally, slightly inflated on the ventral side; dorsal surface uneven, malleate, a few of the later chambers papillate; ventral surface smooth except for etched area at points of contact with shell; chambers increase regularly in size, the initial two or three being obscured by an incipient boss formed by the crowding of the limbate sutures; all other chambers are visible from the dorsal side, from the ventral side only those of the last formed whorl of nine chambers are visible; sutures limbate on the dorsal side but variably beaded, interrupted or welt-like, deeply incised on the ventral side; the umbilical area partially filled with a deposit of clear shell material disposed as blobs and nodes but not closing the central area; aperture a low arched opening at the base of the last formed chamber extending toward the umbilicus. Greater diameter of holotype, 4.4 mm.; lesser diameter, 3.9 mm.; two paratypes measure 5.6 and 4.6 mm. respectively.

Holotype, No. 9517, and *paratypes,* Nos. 9518, 9519, Calif. Acad. Sci. Dept. Paleo. Type Coll., from California Fish and Game vessel *N. B. Scofield* dredge haul 50–B–18 (Loc. 33, 178 (Calif. Acad. Sci.)), in the Pacific Ocean **ten miles southeast of Shelter Cove, Mendocino County, California,** in 85–92 fathoms, October 12, 1950; G D. Hanna, collector.

Eight specimens were found at this locality, all attached to the outer surfaces of living brachiopods *(Laqueus californianus* Koch) which in turn reasonably clear of mud and sand. At each place of attachment some of the shell substance had been dissolved or eroded away leaving a pit a little larger were attached to detached pebbles. The bottom at this place seemed to be than the test of the foraminifer. Hertlein and Grant have noted that Fenton observed pits on the shells of specimens belonging to the genus *Laqueus* and attributed them to the attachment of other individual brachiopods. While it is true that individuals of *Laqueus* are often attached to each other in this manner, Dr. Hanna, who has dredged a great many, states that he has not seen a pit formed under such circumstances.

Mr. Delbert Goodwin who was also attached to the same research project, collected an additional lot of six specimens from a rock dredged in 128 fathoms at Fish and Game motorship *N. B. Scofield* Sta. 51–B–7 (Loc. 33, 246 Calif. Acad. Sci.), February 17, 1951, off Santa Barbara County, California, with Anacapa Island bearing 152° True, eight miles distant. These specimens are slightly smaller than those of the original lot. Four of these are here designated as paratypes Nos. 9520, 9521, 9522, 9523, Calif. Acad. Sci. Dept. Paleo. Type Coll.

A search of the literature failed to disclose any species of *Discorbis* which could be compared readily to the present one. There is a living form, however, which in size and general appearance does approximate it. This is the species referred to by Cushman and Gray (1946, p. 38, pl. 7, figs. 1a, b, c.) as *Eponides repandus* (Fichtel and Moll). In its younger stages this has the defining characters of *Eponides* but older specimens develop extra shell material in the umbilical area with attendant coarse pores and irregular openings which tend to obscure the generic features. In this latter stage *Eponides repandus* is similar to the present species. It is much flatter, however, and the apertural area is simpler and more nearly a plate-like covering. The deeply eroded character of the umbilical area of the new species and its more conical test sets it apart.

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CORRECTION

Please read line 12 before line 10 on this page.

PROCEEDINGS

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Vol. XXVII, No. 12, pp. 377–381, pl. 20, figs. 12 and 13 July 11, 1952

DESCRIPTION OF A NEW PELECYPOD OF THE GENUS *LIMA* FROM DEEP WATER OFF CENTRAL CALIFORNIA

BY

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California Academy of Sciences

Dredgings secured during off shore work on the U. S. *Mulberry* during 1950 on U. S. Naval Research Project Number N9 onr 94400, yielded marine mollusks from many stations. Most of the species dredged in waters less than 100 fathoms deep are known from other localities, but in several instances their occurrence off central California added to the known range of the species.

Biologic material from deep water is of more than usual interest. It is scarce in collections because of the difficulty of recovering mollusks and similar organisms at great depths. Some of the genera of mollusks represented in the present collections from deep water are *Solemya,* a pelecypod, and *Cocculina,* a gastropod. The widespread occurrence of deep water species, or groups of extremely similar forms, over vast areas of the ocean bottom aids studies concerning the past and present distribution of marine faunas.

Specimens of a bivalve mollusk, *Lima,* dredged off San Mateo County in 690–800 fathoms are therefore of special interest. Species belonging to the same subgenus have been found occurring as fossils in California, Oregon, and Washington, but living species have been known along the western Americas from off southern Chile, Panama, and the Galapagos Islands. Heretofore the only known living representatives in the north Pacific were two occurring off Japan. To this group a new species, *Lima mori,* is now added from off central California.

Class **Pelecypoda**

Family **Limidae**

Genus **Lima** Cuvier

Lima Cuvier, Tableau Elém., 1798, p. 421. Sole species, *Lima alba* Cuvier [=*Ostrea lima* Linnaeus, Syst. Nat., ed. 10, 1758, p. 699. "Habitat in O. meridionali." Ref. to "Argenv. conch. t. 27. f. E."].

The family Limidae has been recorded as occurring in Carboniferous and Permian rocks. Typical forms of the genus *Lima* are known to occur from lower Cretaceous to Recent. At the present time the genus is found at various depths in all oceans. The species can move about by crawling or swimming and some of them build nests. The family is represented in marine waters along the west coast of North and Central America by eight or ten species.

Subgenus **Acesta** H. & A. Adams

Acesta H. & A. Adams, Gen. Rec. Moll., vol. 2, 1858, p. 558. Sole species, "*excavata,* Chem." [Chemnitz, Syst. Conch.-Cab. von Martini und Chemnitz, Bd. 7, 1784, pp. 267 *(Concha excavata),* 355 *(Excavata Fabricii* and *Ostrea excavata),* pl. 68, fig. 654. "an den norwegischen Stranden."=*Ostrea excavata* Fabricius.]

The shells of the members of *Acesta* are usually large, comparatively thin, sometimes somewhat ventricose, and sculptured with radial ribs which are coarser on the anterior and posterior margins and fine or nearly obsolete on the medial portions of the valves. The ligamental pit is oblique. The shell is similar to that of *Plagiostoma* J. Sowerby which was represented by numerous species during the Mesozoic era. *Acesta* differs from Sowerby's subgenus in the less oblique form, generally shorter anterior umbonal ridge, and the shallower ligamental pit. *Pseudacesta* Waagen has as its type *Mysidoptera (Pseudacesta) dieneri* Waagen, a species from the upper Triassic of Austria. Thiele and Woodring have indicated that there is but little difference between *Acesta* and *Callolima* Bartsch which was based upon *Lima (Callolima) rathbuni* Bartsch, a species occurring in Philippine waters. Oyama (1943) and Habe (1951) recently placed *Callolima* in the synonymy of *Acesta.*

Species referable to *Acesta* have been described from strata in western North America which have been referred to the Oligocene and the Pliocene. The subgenus has been recorded elsewhere as occurring throughout the Tertiary and perhaps in the late Cretaceous. At the present time some species occur in moderately deep water (150 fathoms) but most of them occur at greater depths down to 2,000 meters. Lamy (1930) has cited the Recent species.

Lima (Acesta) mori Hertlein, new species

Plate 20, figures 12 and 13

Shell ovate in outline, inequilateral, rather inflated, thin, moderately large, white, the exterior stained light brown along the anterior and posterior margins; hinge line short, straight, with a small, narrow, oblique ligamental pit; beaks eroded, situated near anterior end of hinge line; an elongate, excavated lunular area below beaks, the surface finely radially ribbed; anterior slope oblique; posteriorly, the margin rounds into the hinge with very short slope or none at all; exterior sculptured with numerous radial ribs which are very fine along the medial portion of the valve, nearly obsolete on the umbo but becoming coarser toward the margins, especially anteriorly, about 12–13 per centimeter along the posterior ventral margin; concentric sculpture, very fine, imparting a wavy character to the ribs; interior white, polished, the margin faintly crenated or completely smooth; muscle impression rather small, high, posterior; a small projection due to the upturned shell margin is present at the anterior end of the hinge. Dimensions (ventral margin incomplete); height, 61.8 mm.; length, 55 mm.; convexity (one valve), 15.8 mm.; length of hinge, 15.5 mm.; length of anterior umbonal ridge, 23 mm.

Holotype, right valve, No. 9524, Calif. Acad. Sci. Dept. Paleo. Type coll., from Loc. 33027 (C. A. S.), U. S. *Mulberry* Station 38, Lat. 37°26.5′ N., Long. 123°28.7′ W., **Mulberry Seamount,** in 690 to 800 fathoms, rock, shells. A portion of a left valve present in the same dredge haul apparently represents the opposite valve of the type specimen.

The general shape of the species here described as new is similar to that of *Lima (Acesta) diomedae* Dall[1] (1908, p. 407, pl. 7, fig. 2), described from near the Galapagos Islands in 385 fathoms. It differs from that species in the much finer radial ribbing and thinner shell. *Lima (Acesta) agassizii* Dall[2] (1902, p. 16) and (1908, p. 407, pl. 16, fig. 1), described from the Gulf of Panama in 322 fathoms, and the similar *Lima (Acesta) hamlini* Dall (Woodring, 1938, p. 47, pl. 8, figs. 5, 7, 10, 11), from the Pliocene of Los Angeles basin, are higher in proportion to the length than either *L. mori,* n. sp. or *L. diomedae.* Other fossil forms bearing a general resemblance to *L. hamlini* were described as *Lima (Plagiostoma) oregonensis* Clark[3] (1925, p. 84, pl. 14, figs. 3 and 4), from the Oligocene of Oregon, and *Lima robertsae*

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[1] "U. S. S. *Albatross,* station 3404, near the Galapagos Islands, in 385 fathoms, rocky bottom, temperature 43.2° F. U.S.N. Mus. 122,875."

[2] "From the Gulf of Panama in 322 fathoms."

[3] "Occurrence—U. C. loc. 4118. Railroad tunnel about ten miles out of town of Buxton toward Tillamook, Oregon."

Durham[4] (1944, p. 139, pl. 13, fig. 10), and *Lima twinensis* Durham[5] (1944, p. 139, pl. 13, fig. 11), from beds referred to the Oligocene in Washington. *Lima (Acesta) patagonica* Dall (1902, p. 16[6], and 1908, p. 407[7]), described from off southern Chile in 245–481 fathoms, was compared to *Lima (Acesta) goliath* Sowerby (1883, p. 30, pl. 7, fig. 3)[8], from Japan and *Lima (Acesta) excavata* Fabricius (Sars, 1878, p. 24, pl. 3, figs. 1a–d; Friele & Grieg, 1901, p. 6; and Lamy, 1930, p. 187), from northern Europe.

Lima (Acesta) mori, n. sp., appears to be quite different from any of the giant limas described by Bartsch (1913, pp. 235–240, pls. 12–20), from the Philippine Islands and adjacent regions as well as those cited from the Orient by Oyama (1943, pp. 1–74, pls. 1–14, 12 text figs.).

This species is named for the ship U. S. *Mulberry.* The specific name is derived from the Latin word ''morus'' meaning mulberry.

Two species of gastropods, *Cidarina cidaris* A. Adams and *Calliostoma platinum* Dall, also obtained by dredging off the coast of California, are illustrated on the plate with the new species of *Lima.*

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[4] From "loc. A3210" ("Upper Oligocene, Blakeley formation, Kitsap County, Washington. In shale to east of small anticline, south side of Richs passage. NE. ¼ of NW. ¼ of sec. 9, T. 24N., R. 2E.").

[5] From "loc. A3694" ("Upper Oligocene, Upper Twin Rivers formation, Clallam County, Washington. From calcareous concretions in seacliff. Center of SW. ¼ of SW. ¼ of sec. 18, T. 31N., R. 10W.").

[6] "From the west coast of Patagonia (245–481 fms.)."

[7] As *Lima (Acesta) patagonica,* southern Chile, in 348 fathoms.

[8] "Hab. Japan." A subspecies, *Lima (Acesta) goliath yagenensis* Otuka, 1939, has been described from the Miocene of Japan.

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Vol. XXVII, No. 13, pp. 383–387, pl. 20, figs. 2, 3, and 4 July 11, 1952

SHELLS FROM THE BIRD GUANO OF SOUTHEAST FARALLON ISLAND, CALIFORNIA, WITH DESCRIPTION OF A NEW SPECIES OF *LIOTIA*

BY

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In May, 1949, opportunity was afforded to spend a week on Southeast Farallon Island in company with Dr. G Dallas Hanna, Curator of the Department of Paleontology, California Academy of Sciences. The purpose was to investigate the geology of the island. A further desire was to observe existing faunal conditions and to make additions to the Academy's collections. More information on some of the lesser known aspects of the marine fauna was also desired, preliminary to an extensive oceanographic program subsequently begun in the fall of 1949 under a special contract between the California Academy of Sciences and the U. S. Office of Naval Research (N9 onr 94400).

Southeast Farallon is a bare and rugged, rocky island about a mile long and half a mile wide, lying 27 miles west of the Golden Gate. It is approximately the southern end of a ridge about 30 miles long with Cordell Bank, off Point Reyes, marking its northern extremity. In between lie the North Farallon Islands, a group of four pointed rocks rising abruptly out of the sea, and the Middle Farallon, a small rock that is awash at high tide. The North Farallons are uninhabited; so far as known, no one has made a landing on them for at least half a century. Southeast Farallon, however, lies directly in the ship lane from San Francisco to Honolulu, and the U. S. Coast Guard maintains a permanent establishment there for the operation of a lighthouse, foghorn, and radio installations for various purposes, including the transmission of weather reports.

Southeast Farallon is noted for the vast number of birds that nest there. Here are the great rookeries of the California murre and of cormorants of three species—the Farallon, the Baird, and the Brandt. Other birds nesting here in some profusion are the western gull, the tufted puffin, Cassin's auklet, one or two species of petrel, and the pigeon guillemot. All of these birds, but especially the cormorants and murres, are currently adding to guano deposits to be found toward the northern end of the island.

While on Southeast Farallon much time was devoted to shell collecting, the results of which are of such interest that a more extensive account of them is planned at a later time. However, we had heard of the possibility of finding shells in bird guano and so investigated this source without, at the outset, expecting much. To our surprise we found good hunting in the guano at certain spots—a first experience in over 40 years of collecting where one had to climb steep hills and cliffs to find recent marine species. True, the shells found scattered over the surface were covered with guano, but many of the species were from moderate depths, ordinarily taken only by dredging. For this reason it was easy to overcome a natural aversion to the conditions under which this type of hunting has to be done.

The source of shells in the guano seems rather evident. Cormorants, particularly, obtain some of the fish on which they feed in fair depths of water. Many of these fish feed on small mollusks of various types, swallowing them whole. When caught, the fish are brought in to the nesting sites where they are swallowed by the old or young birds or are torn to pieces, or are left to rot near the nests. Eventually the shells weather out, either from the guano itself or from the rotting fish and may be picked up on the surface. In some instances this weathering process must be fairly rapid, for, after cleaning, some of the shells were found to have the opercula in place although many shells had lost their periostraca. A list of the species found in the guano follows:

Pelecypoda

Cryptomya californica Conrad
Glycymeris cf. G. subobsoleta Carpenter
Hinnites multirugosus Gale
Volsella fornicata Carpenter

Gastropoda

Acmaea pelta Eschscholtz
Acmaea mitra Eschscholtz

Amphissa columbiana Dall
Amphissa versicolor Dall
Amphissa versicolor incisa Dall
Calliostoma costatum Martyn
Calliostoma gloriosum Dall
Crepidula adunca Sowerby
Crepipatella lingulata Gould
Fusinus (species?). Juv. specimens
Homalopoma carpenteri Pilsbry
Margarites salmonea Carpenter
Mitra montereyi Berry
Mitrella tuberosa Carpenter
Nassarius cf. N. californianus Conrad, *auct*
Nassarius insculptus Carpenter
Nassarius mendicus Gould
Nassarius mendicus cooperi Forbes
Ocenebra interfossa atropurpurea Dall
Ocenebra lurida aspera Baird
Olivella baetica Carpenter
Seila montereyensis Bartsch
Tegula brunnea Philippi
Tegula pulligo Martyn
Trivia californiana Gray

Amphineura

Nuttallina californica Reeve

Anthozoa

Balanophyllia cf. B. elegans Verrill

Cirripedia

Balanus flos Pilsbry
Balanus nubilis Darwin

The most exciting find in the guano deposits was the following new species of *Liotia* belonging to a group not heretofore found living north of Lower California.

Liotia farallonensis A. G. Smith, new species

Plate 20, figures 2, 3, and 4

Description of the holotype: Shell of medium size for the genus, of fairly heavy substance, globose, whitish, with about four post-nuclear whorls (the nuclear whorls lost). Whorls loosely coiled, rapidly enlarging and descending, the sutures distinct, ending in a circular aperture the plane of which approximately coincides with the axial plane of the shell. Axial sculpture of coarse ribs, subequally spaced, of which there are 12 on the body whorl and about the same number on the penultimate whorl. Spiral sculpture consisting of two prominent carinae, the first strong and located at the periphery of the whorls, the second weaker and lying below it. Base with two progressively weaker carinae which spiral down into the umbilicus.

Points where the axial and spiral sculpture cross are drawn out into blunt-pointed projecting tubercles, strongest at the periphery, giving the shell a multi-stellate aspect in the top view. Spaces between the axial and spiral ribs generally subquadrate, more elongated above the periphery in the axial direction. Basic shell sculpture rude, consisting of a thin, apparently spongy layer with a layer of nacre underneath. Aperture entire, the edge thickened by a terminal axial rib, pearly within, of a golden orange color. Operculum horny, shallowly conical, spiral, consisting of many closely set turns of vertical fin-like projections set on the horny base and decorated at the tops of an abundance of narrow strap-like projections, which tend to give the outer edge of the operculum a fringed appearance under fairly high magnification (x 90). These do not extend to the center of the operculum, which is a small circular area without decoration. Altitude of shell, 10.3 mm.; maximum diameter, 12.9 mm.; altitude of aperture, 5.6 mm.; diameter of umbilicus, 1.9 mm.

Holotype: No. 9527, Calif. Acad. Sci. Dept. Paleo. Type Coll., from bird guano, **Southeast Farallon Island, California,** collected by A. G. Smith, May 10, 1949; *Paratype,* No. 9528, Calif. Acad. Sci. Dept. Paleo. Type Coll., found at the same time and at approximately the same location as the type by G D. Hanna. The single paratype is a smaller shell, somewhat more eroded than the type, and measures: altitude, 8.4 mm.; maximum diameter, 10.2 mm.; altitude, of aperture, 4.4 mm.; diameter of umbilicus, 1.7 mm. It has about three and one quarter whorls exclusive of the lost nucleus. Two specimens were taken at Loc. 32935 (C. A. S.), Station 11 (U. S. S. *Mulberry),* Lat. 37°59.2′ N., Long. 123°27.0′ W., S. W. of Cordell Bank, in 74 fathoms, green mud.

Remarks: Liotia farallonensis belongs to the group including *L. californica* Dall from the Gulf of California (recently collected on Guadalupe Island by Woodbridge Williams), and *L. pacis* Dall from deep water off La Paz, Mexico, which Dall placed in the genus *Arene* according to Strong (1934). Later Burch (1946), on Strong's authority, questionably allocated these two species to *Liotia* along with *L. c-b-adamsi* Carpenter, *L. cancellata* Gray, and *L. fenestrata* Carpenter. He places all other species in the genus *Arene*. It therefore seems the wiser course to place this new species in *Liotia* until the differences between this genus and the genus *Arene* are better understood.

Although both specimens are in only fair condition due to the treatment received and are somewhat eroded, the operculum of each shell was in place. Careful investigation of the one from the holotype failed to show existence of a calcareous deposit under a magnification of x 90 although some of the fins were removed with a dissecting needle.

Liotia farallonensis is at once distinguished from *L. californica* by its much smaller size and its greater number of axial ribs (12 instead of 6 per whorl). *Liotia pacis* is about the same size but has 8 ribs per whorl.

For identification of the barnacles in the preceding list and for the excellent photographs of the *Liotia* thanks are due to Mr. Frank L. Rogers of the California Academy of Sciences.

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PROCEEDINGS

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Vol. XXVII, No. 14, pp. 389—392, pl. 20, figs. 6, 10, and 11,
text figs. 1, 2, and 3 July 11, 1952

A RARE SPECIES OF CHITON FROM PIONEER SEAMOUNT OFF CENTRAL CALIFORNIA

BY

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AND

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In connection with the submarine geological work of the California Academy of Sciences under Contract No. N9 onr 94400 much biological material of interest was secured. Since the project was primarily organized to obtain rocks in quantity from deep water, sessile organisms were especially likely to appear in the dredge. Among other things, a great many mollusks of the order Polyplacophora (chitons) were obtained. In the dredge haul at Station 27 on Pioneer Seamount two individuals of a species of *Placiphorella* were found attached to one of the volcanic rocks. There were practically no other living organisms present but large, rigid, siliceous sponges, all dead, were abundant. The chitons seem to answer the very brief, preliminary description which was given for the following species.

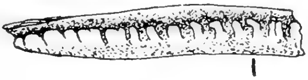
Placiphorella (Placophoropsis) pacifica Berry

Plate 20, figures 6, 10, and 11; text figures 1, 2, and 3

Placiphorella pacifica BERRY, Lorquinia, Jan. 1919, p. 6. Sta. 4245, 95–98 fathoms, Kasaan Bay, Alaska *(Albatross)*. DALL, Bull. 112, U. S. Nat. Mus., 1921, p. 196.

The original description appeared in a publication which is to be found in few libraries and we have seen no additional information regarding the species. Therefore, it is quoted as follows:

"Shell obovate, depressed. Anterior valve with 12–14 low, radiating ribs. Central areas of median valves nearly smooth; lateral areas raised, ornamented with 2 low, weakly nodulose ribs. Tail valve small, with subterminal mucro. Head valve with 16 slits, median valves with 1–1 slits, tail valve slitless. Girdle narrow behind; expanding into a broad lobe in front; covered dorsally by minute, microscopic spinelets and occasional slender spinose setae and tufts of spines."



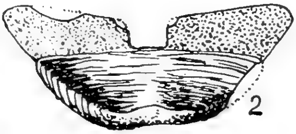


Fig. 1. Front view of half of anterior valve showing the number and the approximate shape of the "teeth" or "slits" on the insertion plate. Total width of anterior valve, 13.7 mm.; of this half, 6.6 mm. From hypotype No. 9529 (C. A. S.).

Fig. 2. Top view of posterior valve showing the squared notch in the insertion plate. Total width, left to right, 8.0 mm. From hypotype No. 9530 (C. A. S.).

Fig. 3. One of the long spinose plumule-like projections from the mantle showing length and approximate positions of the spines. Length, 2.0 mm. From hypotype No. 9529 (C. A. S.).

The type locality, U. S. S. *Albatross* Sta. 4245, is described in detail in Rept. U. S. Com. Fish & Fisheries for 1903 (1905), p. 130. Kasaan Bay is on Prince of Wales Island, southeast Alaska, and the date of collecting was July 11, 1903.

While the original description is somewhat generalized and without measurements or illustrations it is believed that there is a fair possibility ours may belong to the same species as the specimen or specimens dredged by the *Albatross* party. Some other species range from relatively shallow northern waters to deeper zones to the southward. Our specimens came from a depth of 500–650 fathoms and were obtained on the flank of Pioneer Seamount a little south of west of Point Montara, San Mateo County, California, and about 45 miles off shore.

The radiating ribs on the anterior valve mentioned by Berry, are not present on our smaller specimen. On the larger specimen, however, the radiating ribs are present. The posterior margin of this valve is nearly straight in both specimens. Intermediate valves show the "2 low, weakly nodulose ribs" described by Berry. Ground sculpture on all valves of our larger specimen consists of rather rough transverse growth lines, set with small closely spaced rounded granules visible only with low magnification. This granular decoration is well developed on the lateral areas, becomes obsolete on the central areas, and disappears toward the jugum. On the smaller specimen this feature is much less prominent. A prominent feature is the well marked overhang of the tegmentum on all valves.

Entire girdle covered on the dorsal and ventral sides with extremely fine sandy scales and set with short glass-like spicules visible under moderate magnification. In addition, tufts of minute translucent scaleless spines, 3 to 8 in a bunch, are visible in the photographs on both surfaces of the elongated anterior portion of the girdle. These tufts extend back to the posterior end on the upper surface but disappear on the posterior surface from the head backward. Slender, flexible setae, about 2 mm. long, densely covered with spicules branching from the stem, are found on both surfaces. These are more abundant on the dorsal side and especially pronounced around the margin of the girdle. There are seven tentacle-like projections on the precephalic lobe of the mantle plus about three shorter nodes, all with a dense growth of spicules similar to those of the mantle. There are 15 gills on one side and 14 on the other in each specimen.

The smaller specimen, being somewhat damaged in the dredge, was disarticulated and the anterior valve was found to have 24 irregularly shaped projections, somewhat like the hinge teeth of a taxodont such as *Arca*. The spaces between these correspond to the "slits" in chiton terminology. The greater number of teeth (24) in the anterior valve of one of our specimens compared with the number (16) in the one described by Berry appears to be the only tangible major difference between the two. The posterior valve of our smaller specimen is triangular in shape and the insertion plate has a deep square notch medially.

Color of the valves a warm seal brown, lighter in the central areas. In the larger specimen the brown coloration is considerably darker toward the posterior end. Color of girdle a somewhat similar brown.

The presence of numerous "slits" in the anterior valve seems to indicate clearly that these specimens belong in the subgenus *Placophoropsis* Pilsbry (1893: 312). The name was given to "*Placophora (Euplacophora) atlantica*" Verrill & Smith, a deep water species found off the coast of New England. Pilsbry put the subgenus under *Plaxiphora* Gray, and Thiele (1929:11) included it under *Placiphorella.* Our shells differ markedly from *P. atlantica* in shape being almost circular instead of obovate. In addition, the lateral areas of the intermediate valves are bifurcated by rather prominent raised nodulous ribs, whereas in *P. atlantica* the lateral areas are described as "slightly excavated in the middle." Although other features of the shell and girdle approximate those in *P. atlantica,* the differences are enough to give us confidence that we are dealing here with a different species.

Measurements of both specimens in alcohol (the larger shown in the plate) are as follows:

	Larger	*Smaller*
Length of animal	30.9	25.0
Width of animal	23.9	21.4
Height of animal	5.0	4.2
Length of shell	17.5	15.3
Width of shell	17.5	16.0
Extension of girdle from edge of anterior valve	12.8	9.0

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PROCEEDINGS

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Vol. XXVII, No. 15, pp. 393–397 July 11, 1952

SOME DECAPOD CRUSTACEA DREDGED OFF THE COAST OF CENTRAL CALIFORNIA

BY

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In the following pages an attempt has been made to list the species of decapod crustacea which were obtained during the dredging operations of the California Academy of Sciences under Contract No. N9 onr 94400 with the Office of Naval Research. The work was performed largely with equipment designed to secure geological material; nevertheless some interesting and important species were obtained. If equipment which was better adapted to collecting biological material had been used a greater number of forms might have been obtained; however, it is doubtful if such gear as trawls could have been used successfully on the rugged terrain of the continental slopes which was being investigated.

Under each species there is recorded the stations where collected, together with the depth. All stations so indicated are located off the coast of central California between lines drawn westerly from Half Moon Bay and Point Reyes. For complete geographic data for all stations, a preceding paper of this series (Vol. XXVII, No. 9) by G D. Hanna, on the geological results should be consulted. All specimens referred to are deposited in the collections of the Academy.

Gennadas borealis Rathbun

Gennadas borealis Rathbun, Proc. U. S. Nat. Mus., vol. 24, No. 1272, pp. 887–888, 1902. Type locality off Copper Island, Kamchatka, 1,567 fathoms.

This species was collected at Sta. 44, in 1300–1380 fathoms, a locality near Guide Seamount, which is within the known range.

Pasiphaea pacifica Rathbun

Pasiphaea pacifica RATHBUN, Proc. U. S. Nat. Mus., vol. 24, No. 1272, p. 905, 1902. Type locality, off Point Sur, California, 328 fathoms.

One specimen was taken at Sta. 61, in 400–450 fathoms, near Cordell Bank. Three additional specimens, which lacked some diagnostic characters, were collected at Sta. 58 in 600 fathoms.

Acanthephyra cristata Faxon

Acanthephyra cristata FAXON, Bull. Mus. Comp. Zool., vol. 24, No. 7, p. 206, 1893. Type locality, *Albatross* Sta. 3361, latitude north 6°10′0″, longitude west 83°6′0″, 1,471 fathoms; collected also at Sta. 3381, latitude north 4°56′0″, longitude west 80°52′30″, 1,772 fathoms.

Only one specimen was taken at Sta. 62, in 1150–1000 fathoms, approximately 18 miles north of Farallon Light.

Acanthephyra curtirostris Wood-Mason

Acanthephyra curtirostris WOOD-MASON, Ann. Mag. Nat. Hist., Ser. 6, vol. 7, No. 38, p. 195, 1891. Type locality, Bay of Bengal, 840 fathoms.

One specimen was taken at Sta. 62, in 1150–1000 fathoms, off the Farallon Islands, California. This probably extends the northern range of *A. curtirostris* from San Clemente Island to the Farallon Islands.

Hymenodora frontalis Rathbun

Hymenodora frontalis RATHBUN, Proc. U. S. Mus., vol. 24, No. 1272, p. 904, 1902. Type locality, west of Unalaska, 322 fathoms.

This species was collected off San Francisco in 1150–1000 fathoms, at Sta. 62.

Spirontocaris cristata (Stimpson)

Hippolyte cristata STIMPSON, Proc. Acad. Nat. Sci. Phila., vol. 12, p. 33, 1860. Type locality, San Francisco, California.

A number of specimens were taken at Sta. 55, at Drakes Bay, 5 fathoms.

Crago resima (Rathbun)

Cragon resima RATHBUN, Proc. U. S. Nat. Mus., vol. 24, No. 1272, p. 889, 1902. Type locality, off San Diego, California, in 124 fathoms.

Several specimens were taken on Sta. 20, in 62–60 fathoms, on Cordell Bank.

Crago nigricauda (Stimpson)

Cragon nigricauda STIMPSON, Proc. Calif. Acad. Nat. Sci., vol. 1, pt. 2D., p. 97, 1856. Type locality, Tomales Bay, California.

This common shrimp of the California coast was taken well within the known geographic and bathymetric range at Sta. 55, at Drakes Bay, in 5 fathoms.

Lopholithodes foraminatus (Stimpson)

Echidnocerus foraminatus STIMPSON, Ann. Lyc. Nat. Hist. New York, vol. 7, pp. 79–80, 1862. Type locality, off San Francisco, California.

Seventeen of these crabs were taken at Sta. 23, Fanny Shoal, 62 fathoms.

Munida quadrispina Benedict

Munida quadrispina BENEDICT, Proc. U. S. Nat. Mus., vol. 26, No. 1311, pp. 269–270, text fig. 17, 1902. Type locality, off Cape Beale, Vancouver Island, British Columbia, 66 fathoms.

Seven specimens were collected at Sta. 12, 3¾ miles off Cordell Bank, in 218–100 fathoms; 4 additional specimens were taken at Sta. 22, 8 miles off Fanny Shoal, in 400 fathoms.

Munidopsis verrilli Benedict

Munidopsis verrilli BENEDICT, Proc. U. S. Nat. Mus., vol. 26, No. 1311, p. 291, text fig. 34, 1902. Type locality, off San Diego, California, 822 fathoms.

One specimen was collected at Sta. 28, in 600–450 fathoms, off Pioneer Seamount; and one from Sta. 29, 440–450 fathoms, in the same vicinity. This is probably an extension in range for *M. verrilli* from Monterey Bay to Pioneer Seamount, California.

Chorilia longipes Dana

Chorilia longipes DANA, Amer. Journ. Sci. Arts, Ser. 2, vol. 2, No. 32, pt. 6, p. 269, 1851.

Several specimens were collected at Sta. 10, Cordell Bank, in 34 fathoms; also Sta. 22, 400 fathoms.

Chionoecetes tanneri Rathbun

Chionoecetes tanneri RATHBUN, Proc. U. S. Nat. Mus., vol. 16, No. 927, pp. 76–78, pl. 4, figs. 1–4, 1893. Type locality, Gulf of Farallones, California, 29 fathoms.

This species was taken at Sta. 38, on Mulberry Seamount, 690–800 fathoms; also at Sta. 52, off San Francisco, in 300 fathoms.

PLATE 20

Fig. 1. *Discorbis laquei* Church, n. sp. Holotype No. 9517 (C. A. S.) from Pacific ocean 10 miles southeast of Shelter Cove, Mendocino County, California, dredged in 85–92 fathoms. Length, 4.4 mm.; breadth, 3.9 mm. Page 375.

Fig. 2. *Liotia farallonensis* A. G. Smith, n. sp. Holotype No. 9527 (C. A. S.), from Southeast Farallon Island, California, in bird guano. Altitude, 10.3 mm.; maximum diameter, 12.9 mm. Page 385.

Fig. 3. *Liotia farallonensis* A. G. Smith, n. sp. Apical view of specimen shown in figures 2 and 4.

Fig. 4. *Liotia farallonensis* A. G. Smith, n. sp. View of base of specimen shown in figures 2 and 3.

Fig. 5. *Discorbis laquei* Church, n. sp. Edge view of specimen shown in figures 1 and 8.

Fig. 6. *Placiphorella (Placophoropsis) pacifica* Berry. Hypotype No. 9529 (C. A. S.), from U. S. *Mulberry* Station 27, Lat. 37°24.4′ N., Long. 123°23.5′ W., on slope of Pioneer Seamount, in 500–700 fathoms, on volcanic rock. Length, 30.5 mm.; width, 22.5 mm.; height, 5 mm. Page 390.

Fig. 7. *Calliostoma platinum* Dall. Hypotype No. 9525 (C. A. S.), from Loc. 33242 (C. A. S.), *N. B. Scofield*, Calif. Fish and Game vessel, Station 51–B–14, Pacific ocean, in 220–236 fathoms; Santa Cruz Island, California, bears 42°T., about 10 miles distant. Height, 29 mm., maximum diameter, 27.8 mm. Delbert Goodwin collector.

Fig. 8. *Discorbis laquei* Church, n. sp. View of opposite side of specimen shown in figure 1.

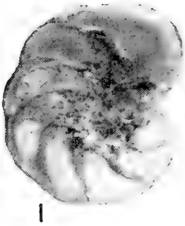
Fig. 9. *Cidarina cidaris* A. Adams. Hypotype No. 9526 (C. A. S.), Loc. 33243 (C. A. S.), *N. B. Scofield*, Calif. Fish and Game vessel, Station 51–B–8, Pacific ocean, in 80 fathoms; Anacapa Light bears 195°T., 9 miles distant. Height, 33 mm.; maximum diameter, 26.8 mm. Delbert Goodwin collector.

Fig. 10. *Placiphorella (Placophoropsis) pacifica* Berry. Dorsal view of specimen shown in figures 6 and 11.

Fig. 11. *Placiphorella (Placophoropsis) pacifica* Berry. Ventral view of specimen shown in figures 6 and 10.

Fig. 12. *Lima (Acesta) mori* Hertlein, n. sp. Holotype, right valve, No. 9524 (C. A. S.), from Loc. 33027 (C. A. S.), U. S. *Mulberry*, Station 38, Lat. 37°26.5′ N., Long. 123°28.7′ W., Mulberry Seamount, in 690 to 800 fathoms. Height, 61.8 mm.; length, 55 mm. View of interior. Page 379.

Fig. 13. *Lima (Acesta) mori* Hertlein, n. sp. View of exterior of specimen shown in figure 12.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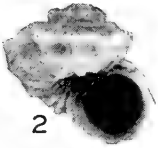
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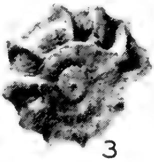
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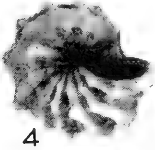
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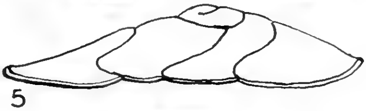
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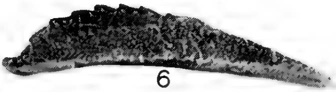
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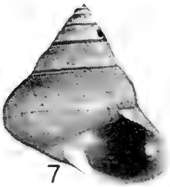
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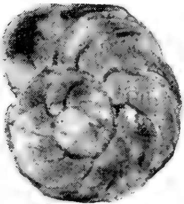
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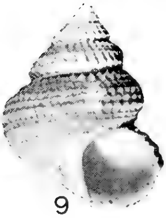
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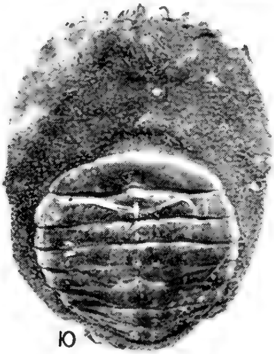
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PROCEEDINGS

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Fourth Series

Vol. XXVII, No. 16, pp. 399–432, plates 21–26 July 11, 1952

ANNOTATED LIST OF FISHES OBTAINED BY THE CALIFORNIA ACADEMY OF SCIENCES DURING SIX CRUISES OF THE U. S. S. *MULBERRY* CONDUCTED BY THE UNITED STATES NAVY OFF CENTRAL CALIFORNIA IN 1949 AND 1950

BY

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On August 19, 1949, the California Academy of Sciences and the United States Navy executed a contract (No. N9 onr 94400 of the Office of Naval Research) which provided for the joint participation of the two institutions in a series of explorations of the waters adjacent to the coastline of central California.

Before the outbreak of the war in Korea terminated the operations, seven members of the Academy's staff had participated in one or more of a total of six cruises, all of which were made aboard the U. S. S. *Mulberry*, a Diesel-electric, twin-screw auxiliary net-layer 151 feet 9⅝ inches in length, Lieutenant James B. Birtch, U. S. N., commanding. The staff members so participating were Robert C. Miller, director; G Dallas Hanna, curator of paleontology; Joseph R. Slevin, curator of herpetology; W. I. Follett, curator of ichthyology; Earl S. Herald, curator of aquatic biology; Robert P. Dempster, aquatic biologist; and Delbert G. Goodwin, assistant in paleontology.

This paper deals with all the fishes obtained during the six cruises. The habitats explored were those from the surface, through intermediate stages, to the sea-bottom in depths of 4.5 to 1100 fathoms, and at offshore distances of 0.7 to 46.6 miles, all within 60 miles of San Francisco.

The fishes taken include shallow-water forms as well as those ranging from the pelagic zone to the sea-bottom at considerable depths. In addition to commoner species of the region, there are some relatively rare forms such as the first recorded embryo and egg-case of *Raja trachura,* several specimens of *Cyclothone pallida,* and one specimen each of *Tactostoma macropus, Myctophum californiense,* and *Nectoliparis pelagicus.* Three extensions of range are represented: a southerly extension (and first recorded occurrence from California waters) for *Neoscopelarchoides dentatus,* and northerly extensions for *Isurus glaucus* and *Sebastodes serranoides.* Two noteworthy extensions of habitat are indicated in the taking far at sea of postlarvae of *Hypomesus pretiosus,* a species that spawns upon sandy beaches, and of *Hemilepidotus spinosus,* which in its juvenile and adult stages inhabits the intertidal and relatively high subtidal zones of rocky shores. The offshore habitat of *Hexagrammos decagrammus* is indicated by the taking of a number of young exhibiting modifications for a pelagic existence. The young stages of five species are illustrated.

NOMENCLATURE

The nomenclature of this paper is that employed by Hubbs and Follett (MS.). Following their precedent, the attributive of the vernacular name is enclosed in parentheses where another species known by the same vernacular occurs only beyond the boundaries of California. Where, on the other hand, more than one form occurring within California is known by the same vernacular, parentheses are omitted from the attributive of each.

Except as otherwise indicated, the original citations required by Declaration 7 of the International Commission on Zoological Nomenclature (1943: 51) may be found in Jordan and Evermann (1896, 1898a, 1898b) or in Jordan, Evermann, and Clark (1930).

ACKNOWLEDGMENTS

For extensive assistance, particularly with the more difficult determinations, I am greatly indebted to Carl L. Hubbs, of the University of California. Elbert H. Ahlstrom, of the U. S. Fish and Wildlife Service, identified the specimens of *Chauliodus macouni* and *Neoscopelarchoides dentatus.* Earl S. Herald and Donald A. Simpson, of the Academy's Department of Aquatic Biology, assisted with the *Sebastodes* gill-raker counts.

Abbreviations and Definitions

In addition to certain conventional abbreviations, those designated below are employed in this paper. Some brief indications of methods used are appended.

A, anal fin rays, counted as by Hubbs and Lagler (1947:8–10).

AOa, anal organ, anterior series, as defined by Bolin (1939b:91).

AOp, anal organ, posterior series, as defined by Bolin (1939b:91).

BR, branchiostegal rays.

CAS, California Academy of Sciences (Department of Ichthyology), followed by the catalog number.

C, principal caudal fin rays, counted as by Hubbs and Lagler (1947:8–10).

D, dorsal fin rays, counted as by Hubbs and Lagler (1947:8–10).

GRa, gill-rakers of the anterior row on the first arch, counted as by Hubbs and Lagler (1947:13).

GRp, gill-rakers of the posterior row on the first arch. These are usually much shorter than those of the anterior row, and are sometimes knoblike.

off, away from, in a seaward direction.

P_1, pectoral fin rays, counted as by Hubbs (1945:130).

P_2, pelvic (ventral) fin rays, counted as by Hubbs and Lagler (1947:8–10).

Pol, posterolateral organ, as defined by Bolin (1939b:91).

postlarva, as defined by Hubbs (1943: 260).

Prc, precaudal organ, as defined by Bolin (1939:91).

SAO, supra-anal organ, as defined by Bolin (1939b:91).

scales, counted as by Hubbs and Lagler (1947:11–12).

SL, standard length (straight line from tip of snout to caudal base), as used by Hubbs and Lagler (1947:13–14).

T, true north.

temperature, of surface water.

time of day, expressed as on a 24-hour chronometer, and invariably indicating Pacific Standard Time (e. g., 0700 = 7 A. M.; 1900 = 7 P. M.).

TL, total length (straight line from most anterior projecting part of head to farthest tip of caudal fin when caudal rays are squeezed together), as used by Hubbs and Lagler (1947: 13).

VO, ventral organ, as defined by Bolin (1939b:91).

Locality Data

First cruise: *August 22–26, 1949*, G Dallas Hanna, Joseph R. Slevin, and Earl S. Herald participating:

Field No. F49–12D: Cordell Bank, E. side; Ship's log, "Sta. 2"; 38°00′00″ N., 123°22′24″ W.; 16.6 miles off Pt. Reyes; August 23; time, 1015–1035; on bottom; depth of water, 57 to 50 fathoms; temperature, 11.1° C. (52° F.); dredge, cylindrical, diameter 18 inches, length 6 feet.

Field No. F49–12E: Cordell Bank; Ship's log, "Sta. 3"; 37°59′42″ N., 123°25′12″ W.; 18.8 miles off Pt. Reyes; August 23; time, 1200–1500; on bottom; depth of water, 34 fathoms; temperature, 11.1° C. (52° F.); hook and line, squid and clam bait.

Field No. F49–12F: Cordell Bank, W. side; Ship's log, "Sta. 5"; 38°00′45″ N., 123°26′30″ W.; 19.7 miles off Pt. Reyes; August 23; time, 1645–1800; on bottom; depth of water, 35 fathoms; temperature, 11.1° C. (52° F.); hook and line.

Field No. F49–12FF, identical with F49–12F except as follows: Time, 1900–2200; at surface; night light and dip-net.

Field No. F49–12G: Cordell Bank, NW. side; Ship's log, "Sta. 7"; 38°03′18″ N., 123°31′12″ W.; 23.7 miles off Pt. Reyes; August 24; time, 1330–1345; on bottom (?); depth of water, 124 to 90 fathoms; dredge, cylindrical.

Field No. F49–12H: Cordell Bank; Ship's log, "Sta. 9"; 38°02′00″ N., 123°24′48″ W.; 18.6 miles off Pt. Reyes; August 24; time, 1635–1830; on bottom; depth of water, 28 fathoms; hook and line.

Field No. F49–12HH, identical with F49–12H except as follows: Time, 1800; at surface; night light and dip-net.

Field No. F49–12I: Cordell Bank; Ship's log, "Sta. 10"; 38°02′12″ N., 123°24′48″ W.; 18.6 miles off Pt. Reyes; August 25; time, 0800–0810; on bottom; depth of water, 34 fathoms; dredge, cylindrical.

Field No. F49–12J: North Farallon Island vicinity (1.1 miles E., 1.0 mile N.); Ship's log, "Sta. 13"; 37°47′00″ N., 123°04′36″ W.; 13.0 miles off Pt. Reyes; August 25; time, 1530–1900; on bottom; depth of water, 42 fathoms; hook and line.

Field No. F49–12JJ, identical with F49–12J except as follows: Time, 1900–2100; at surface; night light and dip-net.

SECOND CRUISE: *September 26–29, 1949*, Robert C. Miller, G Dallas Hanna, W. I. Follett, and Robert P. Dempster participating:

Field No. F49–13: Cordell Bank; Ship's log, "Sta. 15"; 38°00′30″ N., 123°25′15″ W.; 18.8 miles off Pt. Reyes; September 26; time, 1930–2200; at surface to ca. 2 feet; depth of water, 34 fathoms; temperature, 14.4° C. (58° F.) at 2000; dip-net (49 fish); trap, 3-foot cubical screen with electric light in top, side-entrances submerged ca. 2 feet (1 fish).

Field No. F49–14, identical with F49–13 except as follows: September 27; time, 0600–0730; on bottom; temperature, 13.3° C. (56° F.) at 0700; hook and line, squid bait.

Field No. F49–15: Cordell Bank; Ship's log, "Sta. 17"; 38°02′30″ N., 123°26′30″ W.; 19.9 miles off Pt. Reyes; September 27; time, 1930–2300; at surface; depth of water, 40 fathoms; temperature, 14.4° C. (58° F.) at 1900; trap (as in F49–13), side-entrances at water level.

Field No. F49–16, identical with F49–15 except as follows: September 28; time, 0600–0730; on bottom; temperature, 15.8° C. (60.5° F.) at 0700; hook and line, squid bait.

Field No. F49–17: Cordell Bank vicinity (4.4 miles S., 1.2 miles E.); Ship's log, "Sta. 19"; 37°55′15″ N., 123°24′05″ W.; 18.4 miles off Pt. Reyes; September 28; time, 1624–1700; on bottom; depth of water, 68 fathoms; temperature, 14.4° C. (58° F.) at 1700; dredge, rectangular, 3.5x1x5 feet.

Field No. F49–18: Cordell Bank vicinity (5.0 miles E., 3.9 miles S.); Ship's log, "Sta. 20"; 37°55′45″ N., 123°19′15″ W.; 14.6 miles off Pt. Reyes; September 28; time, 1715–1755; on bottom; depth of water, 62 fathoms; temperature, 14.4° C. (58° F.) at 1800; dredge, rectangular, 3.5x1x5 feet.

Field F49–19: Cordell Bank; Ship's log, "Sta. 21"; 38°00′15″ N., 123°26′00″ W.; 19.4 miles off Pt. Reyes; September 29; time, 0600–0700; on bottom; depth of water, 28 fathoms; temperature, 15.5° C. (60° F.) at 0700; hook and line, squid bait.

Field No. F49–20: Fanny Shoal vicinity (8.1 miles W.); Ship's log, "Sta. 22"; 37°48′40″ N., 123°23′00″ W.; 20.3 miles off Pt. Reyes; September 29; time, 0843–1000; on bottom; depth of water, ca. 400 fathoms; temperature, 13.9° C. (57° F.) at 1000; dredge, rectangular, 3.5x1x5 feet.

THIRD CRUISE: *February 6–9, 1950,* G Dallas Hanna and Earl S. Herald participating:

Field No. F50–A1: "Mulberry Seamount," 22.7 miles W. and 15.4 miles S. of Southeast Farallon Island; Ship's log, "Sta. 32"; 37°26′30″ N., 123°28′42″ W.; 46.6 miles off Pt. Montara; February 8; time, 1700–1815; on bottom; depth of water, 1000 to 700 fathoms; dredge, cylindrical, diameter 15 inches.

FOURTH CRUISE: *February 13–17, 1950,* G Dallas Hanna participating:

Field No. F50–1A: Guide Seamount (NW. flank), 47.4 miles W. and 4.5 miles S. of Año Nuevo Island; Ship's log, "Sta. 43"; 37°02′00″ N., 123°20′00″ W.; 45.7 miles off Pigeon Point; February 14; time, 1649–1825; depth of capture, unknown; depth of water, 980 fathoms; temperature, 11.7° C. (53° F.); tow-net, diameter 45 inches, mesh ¼-inch; 40-pound weight attached; 300 fathoms of ⅜-inch wire out.

Field No. F50–1AA, identical with F50-1A except as follows: Time, ca. 1900; at surface; dip-net.

Field No. F50–1B: Off Waddell Creek (= "Big Gulch") mouth (30.5 miles W.); Ship's log, "Sta. 46"; 37°05′30″ N., 122°55′00″ W.; 25.5 miles off Pigeon Point; February 15; time, 1850–2040; depth of capture, unknown; depth of water, 420 fathoms; temperature, 10.6° C. (51° F.); tow-net, diameter 45 inches, mesh ¼-inch; 300 fathoms of ⅜-inch wire out.

Field No. F50–1BB, identical with F50-1B except as follows: Time, ca. 2100; at surface; dip-net.

FIFTH CRUISE: *March 27–31, 1950,* Robert C. Miller, G Dallas Hanna, W. I. Follett, and Delbert G. Goodwin participating:

Field No. F50–A7: Southeast Farallon Island vicinity (3.1 miles W., 1.8 miles S.); Ship's log, "Sta. 54"; 37°40′12″ N., 123°03′50″ W.; 26.2 miles off Pt. San Pedro; March 27; depth of capture, unknown; depth of water, 44 to 33 fathoms; dredge, cylindrical, diameter 20 inches, length 67 inches.

Field No. F50–7: Drakes Bay; Ship's log, "Sta. 55"; 38°00′20″ N., 122°57′06″ W.; 1.1 miles offshore; March 28; time, 1130–1830; on bottom; depth of water, 4.5 fathoms; temperature, 9.4° C. (49° F.) at 1810; hook and line, squid bait.

Field No. F50–7A, identical with F50–7 except as follows: Time, 1945–2400; at surface; night light and dip-net.

Field No. F50–8: Cordell Bank vicinity (5.3 miles W., 1.7 miles N.); Ship's log, "Sta. 56"; 38°03′50″ N., 123°33′30″ W.; 25.7 miles off Pt. Reyes; March 29; time, 1230; on bottom; depth of water, 400 to 200 fathoms; dredge, cylindrical, diameter 20 inches, length 67 inches.

Field No. F50–9, identical with F50–8 except as follows: Ship's log, "Sta. 57"; time, 1340–1405; depth of capture, unknown; depth of water, 400 fathoms; tow-net, diameter 45 inches, length 12 feet, mesh ½-inch; 400 fathoms wire out.

Field No. F50–10: Cordell Bank vicinity (5.5 miles W.); Ship's log, "Sta. 58"; 38°00′30″ N., 123°33′00″ W.; 25.0 miles off Pt. Reyes; March 29; time, 1448–1530; depth of capture, unknown; depth of water, 600 fathoms; tow-net, diameter 45 inches, length 12 feet, mesh ½-inch; 550 fathoms wire out, to net.

Field No. F50–11: Cordell Bank vicinity (0.7 mile S.); Ship's log, "Sta. 59"; 37°59′10″ N., 123°25′15″ W.; 18.8 miles off Pt. Reyes; March 29; time, 1745–2145; on bottom; depth of water, 30 fathoms; temperature, 10.3° C. (50.5° F.) at 2210; hook and line, squid bait.

Field No. F50–12, identical with F50–11 except as follows: March 30; time, 0545–0800; temperature, 10.3° C. (50.5° F.) at 0900.

Field No. F50–13: Cordell Bank vicinity (5.2 miles S., 1.9 miles W.); Ship's log, "Sta. 60"; 37°54′30″ N., 123°28′00″ W.; 21.6 miles off Pt. Reyes; March 30; time, 0930–1040; depth of capture, unknown; depth of water, 400 to 500 fathoms; tow-net, diameter 45 inches, length 12 feet, mesh ½-inch; 450 fathoms wire out, to net.

Field No. F50–14: Cordell Bank vicinity (8.7 miles S.); Ship's log, "Sta. 61"; 37°51′00″ N., 123°26′00″ W.; 21.2 miles off Pt. Reyes; March 30; time, 1105–1240; depth of capture, unknown; depth of water, 425 fathoms; tow-net, diameter 45 inches, length 12 feet, mesh ½-inch; 580 fathoms wire out, to net.

Field No. F50–A15: Fanny Shoal vicinity (8.3 miles W., 5.9 miles S.); Ship's log, "Sta. 62"; 37°42′30″ N., 123°23′00″ W.; 24.2 miles off Pt. Reyes; March 30; time, ca. 1200 to ca. 1700; on bottom; depth of water, 1000 fathoms; dredge, cylindrical, at end of 2400 fathoms of wire.

Field No. F50–15, identical with F50–A15 except as follows: Time, 1310–1625; depth of capture, unknown; tow-net, diameter 45 inches, length 12 feet, mesh ½-inch; 1500 fathoms wire out, to net.

Field No. F50–16, identical with F50–A15 except as follows: Time, 1325–1542; depth of capture, unknown; tow-net, diameter 45 inches, length 10 feet, mesh ¼-inch; 900 fathoms wire out, to net.

Field No. F50–17: North Farallon Island vicinity (ca. 0.2 mile E.); Ship's log, "Sta. 63"; 37°46′15″ N., 123°06′00″ W.; 13.9 miles off Pt. Reyes; March 30; time, 1845–2200; on bottom; depth of water, 25 fathoms; temperature, 10.6° C. (51° F.); at 2215; hook and line, squid bait.

Field No. F50–18, identical with F50–17 except as follows: March 31; time, 0517–0715; temperature, 10.6° C. (51° F.) at 0725.

SIXTH CRUISE: *April 6–7, 1950,* Robert C. Miller, G Dallas Hanna, and W. I. Follett participating:

Field No. F50–19: Southeast Farallon Island vicinity (11.9 miles W., 9.0 miles S.); towed thence 5.5 miles, 240° T.; Ship's log, "Sta. 64"; 37°33′00″ N., 123°15′00″ W.; 34.8 miles off Pt. Montara; April 6; time, 1258–1523; depth of capture, unknown; depth of water, 1100 fathoms; tow-net, diameter 45 inches, length 12 feet, mesh ½-inch; 1200 fathoms wire out, to net.

Field No. F50–20, identical with F50–19 except as follows: Time, 1245–1555; tow-net, diameter 45 inches, length 10 feet, mesh ½-inch; 1800 fathoms wire out, to net.

Field No. F50–21: "Mulberry Seamount," 22.6 miles W. and 14.4 miles S. of Southeast Farallon Island; Ship's log, "Sta. 65"; 37°27′25″ N., 123°28′30″ W.; 45.8 miles off Pt. Montara; April 6–7; time, 2045–0220; at surface; depth of water, 750 fathoms; temperature, 10.6° C. (51° F.) at 0220; night light and dip-net (scrim).

Field No. F50–22: Drakes Bay; Ship's log, "Sta. 66"; 38°00′30″ N., 122°58′00″ W.; 0.7 mile offshore; April 7; time, 0900–1000; on bottom;

depth of water, 5.5 fathoms; temperature, 10.8° C. (51.5° F.) at 1000; hook and line, prawn and beef bait.

The positions were determined from United States Coast and Geodetic Survey charts 5402 (dated 1941), 5502 (1947), and 5599 (1941).

SPECIMENS COLLECTED

LAMNIDAE—mackerelsharks

Isurus glaucus (Müller and Henle)—bonitoshark.
Oxyrhina glauca Müller and Henle, 1841:69, col. pl.

Cordell Bank, F49–12I, 34 fathoms (1 tooth, CAS 25593).

This record constitutes a northerly extension of the range of this species, which has been recorded by Roedel and Ripley (1950:44) as occurring "from Monterey Bay south."

SCYLIORHINIDAE—catsharks

Apristurus brunneus (Gilbert)—brown catshark.

Cordell Bank vicinity, F49–17, 68 fathoms (1 egg-case, CAS 25610).

The identification of this specimen is based upon the description published by DeLacy and Chapman (1935:64).

CARCHARHINIDAE—graysharks

Prionace glauca (Linnaeus)—blueshark.

Cordell Bank, F49–12I, 34 fathoms (1 apical fragment of tooth-crown, CAS 25594).

Galeorhinus zyopterus Jordan and Gilbert—soupfin.
Cordell Bank, F49–12I, 34 fathoms (1 tooth, CAS 25595).

RAJIDAE—skates

Raja trachura Gilbert—roughtail skate.

"Mulberry Seamount," F50–A1, 1000 to 700 fathoms (1 male embryo, TL 185 mm., and its egg-case, extreme length 210 mm.; CAS 25617).

To the naked eye, the egg-case (pl. 21, fig. 1) appears longitudinally striate. Under low magnification, each of the striae is seen to bear a dense series of translucent brownish villi, which render the surface of the egg-case plushlike to the touch.

The dorsal surface of the embryo (pl. 21, fig. 2) is covered with embedded spinules, which tend to form longitudinal rows, and which become more closely approximated along the upper sides of the tail. None of these spinules is enlarged in the region of the orbital rims or in the middle of the back. From a point nearly opposite the posterior attachment of the pectoral fins, a dorsal series of 27 enlarged but embedded spines extends along the midline of the tail to the origin of the first dorsal fin. The first dorsal fin bears 4 spinules on its left side and 7 on its right; the second dorsal bears 4 on the left side and 3 on the right.

The anterior pelvic lobe is fleshy, subterete proximally (its tip vertically compressed), and is somewhat remote from the posterior lobe, but does not arise from the ventral surface of the disc independently of the posterior lobe as in *Cruriraja* Bigelow and Schroeder (1948: 549).

A full description of this embryo and egg-case is being prepared by Hubbs and Follett. The species has previously been recorded only from off Pt. Loma, California (Gilbert, 1892: 539), from south of Santa Rosa Island, California (Townsend and Nichols, 1925: 6), and from south of Shumagin Islands, Alaska (Gilbert, 1895: 398).

? **Raja stellulata** Jordan and Gilbert—starry skate.

Fanny Shoal vicinity, F49–20, ca. 400 fathoms (3 egg-cases, CAS 25616).

These egg-cases do not exactly resemble those of any of the species of *Raja* heretofore recorded from California. They are characterized by the moderate size and by the rather sharp even ridges that are not disrupted into nodules. Since the egg-cases of other California species have been recognized, it is assumed that these specimens may represent *Raja stellulata*, not of most authors but rather the species described by Gilbert (1915: 307, pl. 14, fig. 1) as *Raja montereyensis*. Species of skates along the Pacific coast of the United States are under investigation by Hubbs and Follett.

CHIMAERIDAE—chimaeras

Hydrolagus colliei (Lay and Bennett)—ratfish.

Cordell Bank, F49–12D, 57 to 50 fathoms (1 egg-case, CAS 25581). Cordell Bank vicinity: F49–17, 68 fathoms (1 egg-case, CAS 25611); F49–18, 62 fathoms (3 egg-cases, CAS 25613); F50–8, 400 to 200 fathoms (1 egg-case, CAS 25637).

ENGRAULIDIDAE—anchovies

Engraulis mordax mordax Girard—ocean northern anchovy.

Cordell Bank, F49–12HH, surface (1 postlarva, SL 33 mm., CAS 25591).

OSMERIDAE—smelts

Hypomesus pretiosus (Girard)—surf smelt.

Southeast Farallon Island vicinity, F50–A7, 44 to 33 fathoms (30 postlarvae, SL 12 to 34 mm., CAS 25634).

These specimens of a surf-spawning species were brought up with a number of crinoids, and may have been captured when the dredge was near the surface, although it would seem more probable that they were taken in deep water. Clemens and Wilby (1946: 99) noted that "The young disappear after hatching and may return in the first, second or third year."

In a 31-mm. specimen of this series the scales have not yet appeared, and the myomeres (about 67) are conspicuous. There are 2 large melanophores on the upper third of the operculum, and a series of about 33 on each side of the midline of the ventral surface (pl. 22).

BATHYLAGIDAE—blacksmelts

Leuroglossus stilbius Gilbert—(California) smoothtongue.

Off Waddell Creek, F50–1B, 300 fathoms wire out (1 adult, SL 69 mm., CAS 25622); Cordell Bank vicinity, F50–14, 580 fathoms wire out (1 half-grown, SL 40 mm., CAS 25653).

Bathylagus alascanus Chapman—Alaska blacksmelt.
Bathylagus alascanus Chapman, 1939:505, fig. 58.

Fanny Shoal vicinity, F50–16, 900 fathoms wire out (1 half-grown, SL 78 mm., CAS 25663).

Bathylagus wesethi Bolin—southern blacksmelt.
Bathylagus wesethi Bolin, 1938:66, fig. 23.

Fanny Shoal vicinity, F50–16, 900 fathoms wire out (2 large young, SL 28 and 31 mm., CAS 25664).

These specimens have been compared with the holotype and a paratype of *B. wesethi* and have been found identical. The dorsal- and anal-ray counts are 12–13 and 15, respectively (all rays counted). There are several longitudinal rows of large melanophores in clear areas along the midsides, and the mouth and the opercular and visceral regions are blackish.

STERNOPTYCHIDAE—lightfishes

Cyclothone signata Garman—showy bristlemouth.

Cordell Bank vicinity: F50–10, 550 fathoms wire out (4 half-grown, SL 21 to 30 mm., CAS 25640); F50–14, 580 fathoms wire out (2 half-grown, SL 29 mm., CAS 25656). Fanny Shoal vicinity: F50–15, 1500 fathoms wire out (1 half-grown, SL 24 mm., CAS 25661); F50–16, 900 fathoms wire out (1 half-grown, SL 32 mm., CAS 25666); Southeast Farallon Island vicinity, F50–20, 1800 fathoms wire out (2 half-grown, SL 24 and 25 mm., in poor condition; identification uncertain; CAS 25674).

Cyclothone acclinidens Garman—benttooth bristlemouth.

Cordell Bank vicinity, F50–14, 580 fathoms wire out (2 half-grown, SL 22 and 32 mm., CAS 25655); Fanny Shoal vicinity, F50–16, 900 fathoms wire out (2, half-grown and adult, SL ca. 33 and 51 mm., CAS 25665); Southeast Farallon Island vicinity, F50–19, 1200 fathoms wire out (1 adult, SL 50 mm., CAS 25673).

Cyclothone pallida Brauer—bicolored bristlemouth.
Cyclothone pallida Brauer, 1902:281.

Cordell Bank vicinity: F50–10, 550 fathoms wire out (1 half-grown, SL ca. 38 mm., CAS 25641); F50–14, 580 fathoms wire out (5 half-grown to adult, SL 36 to 44 mm., CAS 25654).

Sternoptyx obscura Garman—dusky hatchetfish.

Fanny Shoal vicinity, F50–16, 900 fathoms wire out (1 small adult, SL 36 mm., CAS 25667).

MELANOSTOMIATIDAE—scaleless dragonfishes

Tactostoma macropus Bolin—longfin dragonfish.
Tactostoma macropus Bolin, 1939a:39, fig. 1.

Cordell Bank vicinity, F50–14, 580 fathoms wire out (1 adult, SL 168 mm., CAS 25657).

D 15; A 22; P_2 10—10; C 10 + 9. Gill-rakers ca. 18 + 32—13 + 34; the upper consisting of 3 remote pairs, with scarcely perceptible rudiments irregularly disposed in the interspaces; the lower arranged predominantly in groups of 2, 3, or 4 teeth that diverge slightly from each other and vary irregularly in size, the longest approximately 0.3 mm. in height.

An irregularly oval cream-white interorbital luminous area, 0.8 mm. long and 0.5 mm. wide, lies opposite the anterior margin of the orbits. A subhorizontal luminous area at the anteroventral margin of the orbit is 1.3 mm. long and 0.1 mm. wide, with a downward curve at the middle. A subvertical luminous area at the anterior margin of the orbit is 0.5 mm. long on the left side of the head, 0.7 mm. long on the right, and 0.1 mm. wide, and is slightly crescentic, with the ends directed backward. These two light organs along the front of the eye are watery gray. The suborbital organ is silvery with a yellow tinge. Two days after this specimen was captured and preserved in formalin, its photophores were cerise.

Bolin (1939a: 40) noted that the barbel of the 71-mm. holotype may have been broken. Chapman (1939: 516, 518), in his original description of *Photonectops multipunctata* (currently regarded as a synonym of this species; cf. Clemens and Wilby, 1946: 110), expressed the same doubt as to the barbel of his 280-mm. holotype, but stated of his 99-mm. paratype that its barbel "is 4 mm. long . . . tapers to a fine point . . . and does not appear to have been broken." (*op. cit.:* 519). The barbel of the present specimen is 2 mm. in length. It is evenly rounded at its tip, and apparently unbroken. An X-ray shows 62 vertebrae in front of the anal fin.

CHAULIODONTIDAE—viperfishes

Chauliodus macouni Bean—(Pacific) viperfish.

Cordell Bank vicinity, F50–10, 550 fathoms wire out (1 postlarva, SL ca. 40 mm., CAS 25642).

SCOMBERESOCIDAE—sauries

Cololabis saira (Brevoort)—(Pacific) saury.

Scomberesox saira Brevoort, 1856: 281 (misprinted "*Scomberescox*" in heading), col. pl. 7, fig. 4.

Cordell Bank, surface: F49–12FF (3 young to adult, SL 44 to 268 mm., CAS 25586); F49–12HH (31 young, SL 45 to 89 mm., CAS 25592); F49–13 (50 young, SL 37 to 78 mm., CAS 25597); F49–15 (127 young, SL 47 to 83 mm., CAS 25604). North Farallon Island vicinity, F49–12JJ, surface (few, discarded). Off Waddell Creek, F50–1BB, surface (1 adult, SL 237 mm., CAS 25629).

The remote possibility that *Cololabis adocetus* Böhlke (1951: 83) might be represented in these series was eliminated by the following counts of the pectoral rays of each of the 212 catalogued specimens: 13—13 (124), 14—14 (23), 12—12 (20), 12—13 (12), 13—14 (12), 14—13 (9), 13—12 (8), 14—12 (1), 7—14 (1), 13—? (1), ?—13 (1).

MYCTOPHIDAE—lanternfishes

Tarletonbeania crenularis (Jordan and Gilbert)—blue lanternfish.

Guide Seamount, F50–1AA, surface (18 half-grown, SL 21 to 28 mm., CAS 25621); off Waddell Creek, F50–1B, 300 fathoms wire out (4 half-grown, SL 23 to 45 mm., CAS 25623); Cordell Bank vicinity, F50–13, 450 fathoms wire out (1 half-grown, SL 41 mm., CAS 25650); "Mulberry Seamount," F50–21, surface (81 half-grown to adult, SL 24 to 67 mm., CAS 25676).

A 42-mm. male of CAS 25676 bears 2 Prc on the right side, the posterior about ¾ the diameter of the anterior. They are separated by a space equal to about ⅓ of the diameter of the anterior organ. The single Prc of the left side is situated about ¼ its own diameter farther back than the anterior of the right-hand pair, which it equals in size.

Toward the end of the period during which the specimens of series F50–21 were being collected, a pair of Alaska fur seals *(Callorhinus ursinus)* were observed foraging under the night light, frequently within 10 feet of the ship. They appeared to be feeding upon fish of this species, which constituted 81 of the 85 specimens collected. One of the pair was struck over the back with the long-handled dip-net, after which it remained at a slightly greater distance while the other seal continued its activities as before. Later a Dall porpoise *(Phocoenoides dalli)* foraged briefly within the illuminated area, apparently seeking these fish. The number of fish observed thereupon decreased to such an extent that collecting was discontinued for the night.

Myctophum californiense Eigenmann and Eigenmann—California lanternfish.

"Mulberry Seamount," F50–21, surface (1 adult male, SL 80 mm., CAS 25677).

An X-ray shows 39 vertebrae. Bolin (1939B:107) recorded a male specimen, SL 52.4 mm., with 3 supracaudal luminous glands. The present specimen bears 5 supracaudal luminous glands, the first originating above the interspace between AOp_5 and AOp_6, the fifth extending to a point above AOp_9 (the last of the AOp series). On the left side of the fish, SAO_2 is slightly behind VO_4, although Bolin stated that in his material SAO_2 is directly over or slightly in advance of VO_4.

Diaphus theta Eigenmann and Eigenmann—(California) headlightfish.

Guide Seamount, F50–1A, 300 fathoms wire out (1 adult, SL 49 mm., CAS 25618). Off Waddell Creek, F50–1B, 300 fathoms wire out (5 half-grown, SL 21 to 30 mm., CAS 25624). Cordell Bank vicinity: F50–9, 400 fathoms wire out (1 half-grown, SL ca. 36 mm., in poor condition; identification uncertain; CAS 25638); F50–13, 450 fathoms wire out (4 adults, SL 46 to 51 mm., CAS 25651); F50–14, 580 fathoms wire out (1 adult, SL 44 mm., CAS 25658).

Lampanyctus leucopsarus (Eigenmann and Eigenmann)—northern lampfish.

Guide Seamount, F50–1A, 300 fathoms wire out (3 half-grown to small adult, SL 32 to 53 mm., CAS 25619). Off Waddell Creek, F50–1B, 300 fathoms wire out (18 half-grown to small adult, SL 29 to 58 mm., CAS 25626). Cordell Bank vicinity: F50–10, 550 fathoms wire out (1 adult, SL 63 mm., in poor condition; identification uncertain; CAS 25644); F50–13, 450 fathoms wire out (5 large young to half-grown, SL 23 to 38 mm., CAS 25652). Fanny Shoal vicinity, F50–16, 900 fathoms wire out (2 adults, SL 66 and 68 mm., CAS 25668). Southeast Farallon Island vicinity, F50–20, 1800 fathoms wire out (1 small adult, SL 41 mm., CAS 25675).

Lampanyctus ritteri Gilbert—broadfin lampfish.

Off Waddell Creek, F50–1B, 300 fathoms wire out (1 half-grown, SL 47 mm., CAS 25625).

Lampanyctus regalis (Gilbert)—pinpoint lampfish.

Fanny Shoal vicinity, F50–15, 1500 fathoms wire out (2 adults, SL 66 and 102 mm., CAS 25662).

In the larger specimen the last (7th) AOa on each side is markedly elevated, onto the next scale-row above the preceding AOa, so that one could enumerate 3 Pol. The smaller one has 6 AOa on its left side, 7 on the right, with the last organ not elevated.

This record is not regarded as a northerly extension of the range, because of the fact that Fraser-Brunner (1949: 1085) synonymized *Lampanyctus micropunctatus* Chapman (from British Columbia and Alaska) with this species.

SCOPELARCHIDAE—pearl-eyes

Neoscopelarchoides dentatus Chapman—northern pearl-eye.

Neoscopelarchoides dentatus Chapman, 1939:530, fig. 67.

Cordell Bank vicinity, F50–10, 550 fathoms wire out (1 young, SL 42 mm., CAS 25643).

This record represents a southerly extension of some 900 miles from the southernmost locality (off Cape Scott, Vancouver Island) mentioned in the original description. The identification was made by Elbert H. Ahlstrom, of the U. S. Fish and Wildlife Service, who has taken larvae of the species off central California.

MERLUCCIIDAE—hakes

Merluccius productus (Ayres)—(Pacific) hake.

Fanny Shoal vicinity, F50–A15, 1000 fathoms (1 precaudal vertebra, CAS 25660).

The identification of this specimen is based upon a comparison with the photograph published by Radcliffe (1913: pl. 15) and with skeletal material of *M. productus.*

BOTHIDAE—lefthanded flounders

Citharichthys sordidus (Girard)—Pacific sanddab.

Cordell Bank, F49–12D, 57 to 50 fathoms (2, large young and half-grown, SL 109 and 133 mm., CAS 25582). North Farallon Island vicinity, F49–12J, 42 fathoms (15 small adult to adult, SL 180 to 272 mm., CAS 25596; many others discarded).

PLEURONECTIDAE—righthanded flounders

Psettichthys melanostictus Girard—sand flounder; market name, sand sole.

Drakes Bay, F50–7, 4.5 fathoms (1 small adult female, SL 278 mm., discarded).

Lepidopsetta bilineata (Ayres)—gravel flounder; market name, broadfin sole.

Platessa bilineata Ayres, 1855: [2].

Drakes Bay, F50–7, 4.5 fathoms (1 small adult male, SL 260 mm., discarded).

Microstomus pacificus (Lockington)—slippery flounder; market name, Dover sole.

Guide Seamount, F50–1A, 300 fathoms wire out (1 postlarva, SL 26 mm., CAS 25620).

It has been indicated by Jordan and Evermann (1898b: 2655), by Jordan, Evermann, and Clark (1930: 228), by Norman (1934: 360), and by Schultz and DeLacy (1936: 69) that the original description of this species is contained in the report upon the food fishes of San Francisco, by Lockington (1879c: 43). However, that paper expressly states that this species ". . . has been described as *Glyptocephalus pacificus* in the Proceedings of the National Museum, September, 1879, p. 86." This description by Lockington (1879b: 86) is actually included in the "signature" dated July 2, 1879. The document containing the report on the food fishes of San Francisco carries items (pp. 60, 61) dated November 1, 1879, and was apparently published late in 1879 or early in 1880. The publication containing the original description (Lockington, 1879a: 254) is dated April 19, 1879.

Platichthys stellatus rugosus Girard—(southern) starry flounder.

Drakes Bay: F50–7, 4.5 fathoms (8 small adults, SL 250 to 426 mm., discarded); F50–22, 5.5 fathoms (1 small adult, SL 245 mm., CAS 25680; 6 other small adults, SL 260 to 319 mm., discarded).

CARANGIDAE—jacks

Trachurus symmetricus (Ayres)—(Pacific) jackmackerel.

Cordell Bank, F49–15, surface (1 young, SL 56 mm., CAS 25605).

SCORPAENIDAE—rockfishes; market name, rock cod

In all vertebral counts of *Sebastodes* species included in this paper, the first vertebra with a well-developed haemal spine is regarded as the first caudal vertebra. In the several species noted, 10 vertebrae are considered precaudals, as they bear transverse processes and ribs and overlie the body cavity. The fact that several have transverse processes arching under the dorsal aorta does not appear to discount them as precaudals. The 11th vertebra is counted as the first caudal, because it is abruptly longer than the 10th, and much more united bilaterally, and because it lies at the end of the body cavity and supports the first (much enlarged) interhaemal spine. These characters would seem to establish the 11th as a caudal vertebra even though the tip of its haemal spine is bifurcate (to receive the enlarged interhaemal). The two divisions obviously grade together, but the sharpest break lies between the 10th and the 11th vertebrae. All counts here given include the hypural. I am indebted to Carl L. Hubbs for this elucidation of the vertebral characters of *Sebastodes.*

Gill-raker counts of *Sebastodes paucispinis, S. flavidus, S. miniatus,* and *S. ruberrimus,* made principally from arches excised from discarded specimens, show rather sharp differences between these species (table 1).

Sebastodes paucispinis (Ayres)—bocaccio.
Sebastes paucispinis Ayres, 1854c:178.

Cordell Bank: F49–12E, 34 fathoms (1 adult, SL 540 mm., CAS 25583); F49–12F, 35 fathoms (5 adults, SL 435 to 505 mm., discarded); F49–12H, 28 fathoms (1 adult, SL 605 mm., CAS 25588; 4 others, SL 410 to 510 mm., discarded); F49–14, 34 fathoms (2 small adult males, SL 357 and 400 mm., weight 3 and 4 pounds, discarded); F49–19, 28 fathoms (2 adults, male and female, SL 475 and 492 mm., weight 6 pounds, discarded). Cordell Bank vicinity: F50–11, 30 fathoms (6 adults, SL 410 to 560 mm., discarded); F50–12, 30 fathoms (6 adults, SL 406 to 557 mm., discarded).

Counts on 19 discarded specimens: GRa (upper) 8 (16), 9 (3); GRa (lower) 20 (5), 21 (11), 22 (3); GRa (total) 28 (5), 29 (10), 30 (2), 31 (2); GRp (upper) 5 (2), 6 (16), 7 (1); GRp (lower) 13 (4), 14 (8), 15 (7); GRp (total) 19 (4), 20 (9), 21 (6).

The vertebrae number 10 + 16 = 26 in both specimens of F49–19. Jordan (1921: 491) stated that this species has but 25 vertebrae (including the hypural). Clothier (1951: 67), however, recorded a total count of 26 vertebrae in one or more specimens, presumably taken in southern California.

Sebastodes serranoides Eigenmann and Eigenmann—bass rockfish.

Cordell Bank, F49–14, 34 fathoms (1 adult, SL 390 mm., CAS 25598); Cordell Bank vicinity, F50–11, 30 fathoms (1 adult, SL 385 mm., CAS 25645; another, SL 405 mm., discarded).

Counts on CAS 25598: GRa 8 + 23—9 + 24. The light blotches on the back were prominent in life; the anal and caudal fins brown.

These records constitute a slight northerly extension of range for this species, which has been recorded by Hubbs and Schultz (1933: 21) as occurring from "San Francisco to Lower California."

Sebastodes flavidus Ayres—yellowtail rockfish.

Cordell Bank: F49–12E, 34 fathoms (1 adult, SL 334 mm., CAS 25584; 9 other adults, SL 350 to 425 mm., discarded); F49–12F, 35 fathoms (14 adults, SL 335 to 410 mm., discarded); F49–12H, 28 fathoms (2 adults, SL 360 and 410 mm., CAS 25589; 8 others, SL 340 to 400 mm., discarded); F49–14, 34 fathoms (1 adult, SL 393 mm., CAS 25599; 10 other adults, all females, SL 345 to 400 mm., weight 4 to 6 pounds, discarded); F49–16, 40 fathoms (2 adults, SL 370 and 390 mm., CAS 25606; skull and facial bones of larger specimen; smaller specimen entire; a number of other adults discarded); F49–19, 28 fathoms (5 adults, 1 male, 4 females, SL 310 to 382 mm., weight 2 to 5 pounds, discarded); F50–11, 30 fathoms (5 adults, SL 344 to 367 mm., discarded); F50–12, 30 fathoms (7 adults, SL 307 to 396 mm., discarded).

Counts on 53 discarded specimens: GRa (upper) 9 (4), 10 (23), 11 (23), 12 (3); GRa (lower) 23 (1), 24 (7), 25 (12), 26 (24), 27 (9); GRa (total) 33 (2), 34 (7), 35 (8), 36 (13), 37 (14), 38 (8), 39 (1); GRp (upper) 5 (8), 6 (39), 7 (6); GRp (lower) 18 (2), 19 (6), 20 (19), 21 (22), 22 (4); GRp (total) 24 (4), 25 (7), 26 (16), 27 (20), 28 (5), 29 (1).

Several specimens were conspicuously blotched with black except on the ventral surface. The stomachs of 9 contained few to many glassy tunicates.

Counts on CAS 25606, larger specimen: P_1 i, 8, ix (= 18)—i, 8, ix (= 18); GRa 10 + 25—11 + 25. The vertebrae number 10 + 16 = 26 in 5 specimens (F49–19). Clothier (1951: 67) recorded a total count of 26 vertebrae in one or more specimens, presumably taken in southern California.

Sebastodes pinniger (Gill)—orange rockfish.

Cordell Bank: F49–16, 40 fathoms (2 adults, SL 355 and 395 mm., CAS 25607); F49–19, 28 fathoms (1 adult, SL 345 mm., CAS 25614).

Sebastodes miniatus (Jordan and Gilbert)—vermilion rockfish.

Cordell Bank: F49–12E, 34 fathoms (1 adult, SL 420 mm., CAS 25585); F49–14, 34 fathoms (2 adults, SL 402 and 470 mm., CAS 25600; skull and facial bones of smaller specimen; larger specimen entire; 5 other adults, 4 males, 1 female, SL 365 to 443 mm., weight 4 to 8 pounds, discarded); F49–16, 40 fathoms (1 adult, discarded); F49–19, 28 fathoms (4 adults, 2 males, 2 females, SL 345 to 445 mm., weight 4 to 8 pounds, discarded).

Counts on 16 discarded specimens: GRa (upper) 10 (1), 11 (1), 12 (12), 13 (2); GRa (lower) 25 (6), 26 (8), 27 (2); GRa (total) 36 (2), 37 (5), 38 (6), 39 (2), 40 (1); GRp (upper) 6 (2), 7 (9), 8 (5); GRp (lower) 20 (3), 21 (9), 22 (4); GRp (total) 27 (3), 28 (7), 29 (5), 30 (1).

Counts on CAS 25600, smaller specimen (male, weight 6 pounds): P_1 i, 8, ix (= 18)—i, 8, ix (= 18); GRa 11 + 24—11 + 24. The vertebrae number 10 + 16 = 26 in 4 specimens (F49–19). Jordan (1921: 491) stated that "*R*[*osicola*] *miniatus*" has but 25 vertebrae (including the hypural). Clothier (1951: 67), however, recorded a total count of 26 vertebrae in one or more specimens, presumably taken in southern California.

Sebastodes ovalis Ayres—widow rockfish.

Cordell Bank, F49–16, 40 fathoms (1 adult, SL 360 mm., CAS 25608; another, discarded).

? **Sebastodes wilsoni** Gilbert—little rockfish.

Cordell Bank vicinity, F49–17, 68 fathoms (1 young, SL 53 mm., CAS 25612). Cordell Bank, F49–19, 28 fathoms (4 young, SL 25 to 40 mm.; 2 of these from the stomach of a 417-mm. *Sebastodes miniatus*, 1 from the stomach of a 394-mm. *Sebastodes miniatus*, and 1 from the stomach of a 302-mm. *Sebastodes ruberrimus*; CAS 25615).

These small specimens are in relatively poor condition, and their identification is somewhat doubtful, although corroborated by the following gill-raker counts: 11 + 30—11 + 30; 10 + 30—(?); 11 + 30—(?); 12 + 31—11 + 31; 10 + 31—11 + 32.

Sebastodes wilsoni has been recorded from Oregon by Hubbs (1928: 13) and from British Columbia by Hubbs and Schultz (1932: 323) and by Clemens and Wilby (1946: 214).

Sebastodes rosaceus (Girard)—rosy rockfish.

Cordell Bank: F49–12H, 28 fathoms (2 adults, SL 170 and 207 mm., CAS 25590); F49–14, 34 fathoms (1 adult, SL 203 mm., CAS 25601). Cordell Bank vicinity: F50–11, 30 fathoms (4 adults, SL 181 to 205 mm., CAS 25646; 11 others, SL 173 to 238 mm., discarded); F50–12, 30 fathoms (1 adult, SL 203 mm., CAS 25648, skeletonized; 5 others, SL 191 to 218 mm., discarded).

Counts on CAS 25648: P_1 ii, 7, viii (= 17)—ii, 7, viii (= 17); GRa 10 + 22—10 + 22; vertebrae 10 + 16 = 26.

Clothier (1951: 67) recorded a total count of 26 vertebrae in one or more specimens of this species, and a total count of 27 in another specimen. Presumably these were taken in southern California. The latter record constitutes the first evidence which I have found that tends to corroborate the statement by Jordan (1921: 491) that he counted 27 vertebrae in certain species (not mentioned by name) of *Sebastodes.* It may be noted further that Jordan and Evermann (1898a: 1766) included "Vertebrae 12 + 15" among the generic characters.

Sebastodes constellatus (Jordan and Gilbert)—starry rockfish.

Cordell Bank: F49–14, 34 fathoms (1 adult, SL 310 mm., CAS 25602); F49–16, 40 fathoms (1 adult, SL 310 mm., CAS 25609; 2 others, discarded); F49–19, 28 fathoms (1 adult female, SL 305 mm., weight 2 pounds, discarded). Cordell Bank vicinity: F50–11, 30 fathoms (1 adult, SL 300 mm., discarded); F50–12, 30 fathoms (1 adult, SL 330 mm., skeletonized; CAS 25649).

Counts on 2 discarded specimens: GRa (upper) 9 (2); GRa (lower) 19 (1), 20 (1); GRa (total) 28 (1), 29 (1); GRp (upper) 4 (2); GRp (lower) 15 (2); GRp (total) 19 (2).

Counts from F49–19: P_1 i, 8, ix (= 18)—i, 8, ix (= 18); vertebrae 10 + 16 = 26. CAS 25649: P_1 ii, 7, viii (= 17)—i, 8, viii (= 17); GRa 8 + 19—7 + 19, the 2nd and 3rd lowest fused; vertebrae 10 + 16 = 26.

Sebastodes ruberrimus Cramer—red rockfish.

Cordell Bank: F49–14, 34 fathoms (2 adults, SL 380 and 472 mm., CAS 25603; 2 other adults, SL 425 and 480 mm., discarded); F49–19, 28 fathoms (1 small adult female, SL 302 mm., discarded). Cordell Bank vicinity: F50–11, 30 fathoms (3 adults, SL 415 to 490 mm., discarded); F50–12, 30 fathoms (8 adults, SL 357 to 450 mm., discarded).

Counts on 9 discarded specimens: GRa (upper) 8 (6), 9 (3); GRa (lower) 17 (2), 18 (4), 19 (2), 20 (1); GRa (total) 25 (2), 26 (3), 27 (1), 28 (3); GRp (upper) 4 (1), 5 (8); GRp (lower) 14 (5), 15 (4); GRp (total) 19 (6), 20 (3).

Counts on single specimens: P_1 i, 9, ix (= 19)—i, 9, ix (= 19); GRa 8 + 20—8 + 20, the lowest 4 rudimentary, fused, and barely distinguishable; vertebrae 10 + 16 = 26.

Sebastodes maliger (Jordan and Gilbert)—quillback rockfish.

North Farallon Island vicinity, F50–18, 25 fathoms (1 adult, SL 333 mm., CAS 25671).

Sebastodes nebulosus (Ayres)—China rockfish.

Sebastes nebulosus Ayres, 1854c:178.

North Farallon Island vicinity, F50–17, 25 fathoms (2 adults, SL 303 and 325 mm., CAS 25669).

Counts on smaller specimen: P_1 i, 7, x (= 18)—i, 7, ix (= 17); GRa 8 + 19—7 + 20, the lowest 2 fused; vertebrae 10 + 16 = 26.

TABLE 1

Sebastodes gill-raker counts

The figures are taken from those listed in the body of the text. All rudimentary rakers are included in the count. A raker that straddles the angle of the arch is included in the count of the lower limb. The parenthetical figure that follows the name of the species indicates the number of specimens. Figures separated by a hyphen indicate the minimal and maximal counts, respectively, and are followed, in parentheses, by the average.

Anterior row	Upper limb	Lower limb	Total
S. paucispinis (19)	8– 9 (8.2)	20–22 (20.9)	28–31 (29.1)
S. flavidus (54)	9–12 (10.5)	23–27 (25.6)	33–39 (36.1)
S. miniatus (17)	10–13 (11.9)	24–27 (25.6)	35–40 (37.5)
S. ruberrimus (10)	8– 9 (8.3)	17–20 (18.4)	25–28 (26.7)
Posterior row			
S. paucispinis (19)	5– 7 (5.9)	13–15 (14.2)	19–21 (20.1)
S. flavidus (53)	5– 7 (6.0)	18–22 (20.4)	24–29 (26.3)
S. miniatus (16)	6– 8 (7.2)	20–22 (21.1)	27–30 (28.3)
S. ruberrimus (9)	4– 5 (4.9)	14–15 (14.4)	19–20 (19.3)

ANOPLOPOMATIDAE—sablefishes

Anoplopoma fimbria (Pallas)—sablefish.
Gadus fimbria Pallas, 1814:200.

Off Waddell Creek, F50–1B, 300 fathoms wire out (1 postlarva, SL 6 mm., CAS 25627); "Mulberry Seamount," F50–21, surface (1 postlarva, SL 15 mm., CAS 25678).

The black-tipped pectorals of the young of this species, mentioned by Brock (1940:268), are conspicuous in the 15–mm. specimen (pl. 23). Further comments on the young stages of this species have been published by Bell and Gharrett (1945:98).

HEXAGRAMMIDAE—greenlings; market name, sea trout

Hexagrammos decagrammus (Pallas)—kelp greenling; market name, sea trout.

Off Waddell Creek, F50–1B, 300 fathoms wire out (32 postlarvae, SL 10 to 32 mm., CAS 25628); Cordell Bank vicinity, F50–11, 30 fathoms (1 adult male, SL 312 mm., CAS 25647). North Farallon Island vicinity: F50–17, 25 fathoms (2 adults, SL 295 and 360 mm., CAS 25670; larger specimen skeletonized; smaller specimen entire); F50–18, 25 fathoms (1 adult female, SL 355 mm., CAS 25672).

In the largest specimens of CAS 25628, both pairs of dermal appendages are visible under low magnification. The attenuate supraorbital appendage is approximately 3 times as long as the bluntly rounded occipital appendage. Neither shows any trace of fimbriation. Plate 24 indicates the striped coloration of a 25-mm. specimen of CAS 25628.

Counts on CAS 25670, larger specimen: D XXII, 24; A I, 22; P_1 19—20; C 7 + 8; scales 16–112–34—16–112–34; GRa 4 + 13—4 + 14; BR 6—6; vertebrae 20 + 35 = 55.

From CAS 25672, an unusual color-variant, the following life-colors were noted: Back and sides clear gray, with about 9 longitudinal series of irregular orange spots, these fading to yellow on the lower sides, where the series tend to unite irregularly. Top and sides of head with similar spots; those on the interorbital and occipital regions reduced in size; those on the cheeks tending to form lines radiating from the orbit. Dorsal fins orange, spotted distally and densely blotched basally with gray. Caudal orange. Pectorals, pelvics, and anal yellow. Chin, throat, and ventral surface white.

OPHIODONTIDAE—lingcods

Ophiodon elongatus Girard—lingcod.

North Farallon Island vicinity, F49–12J, 42 fathoms (1 adult female, SL 730 mm., weight 14 pounds, discarded); Cordell Bank, F49–14, 34 fathoms (1 adult, SL 752 mm., TL 33⅞ inches, weight 20 pounds, discarded); Cordell Bank vicinity, F50–12, 30 fathoms (1 adult, SL 575 mm., discarded).

COTTIDAE—sculpins

Scorpaenichthys marmoratus (Ayres)—cabezon.

Drakes Bay, F50–7A, surface (2 young, SL 31 and 39 mm., CAS 25636).

Bolin (1944: 6) ascribed the name of this species to Girard (1854: 131). This was proper at that time, for it was noted in the Proceedings of the Academy of Natural Sciences of Philadelphia, 7, 1854: 129, that publication of Girard's paper was authorized on August 29, 1854; and separates may have been issued at any time after that date, according to An Index to the Scientific Contents of the Journal and Proceedings of the Academy of Natural Sciences of Philadelphia, 1913: vii. Since Bolin's paper was published, however, the International Commission on Zoological Nomenclature (1950a: 219) has ruled that the distribution of authors' separates does not constitute publication. Other language of the International Commission (1950b: 226) would seem to indicate that this ruling does not apply to successive portions, or ''numbers,'' of a volume. Volume 7, ''number'' 4, of the Proceedings of the Academy of Natural Sciences of Philadelphia extends from page 121 to page 167, and thus includes Girard's paper. In the Proceedings of the American Philosophical Society, 6, 1854: 47, 49, 50, that ''number'' is shown to have been received on some date between September 15 and October 6, 1854. This is the earliest record that I have yet encountered. *Hemitripteras marmoratus* Ayres (1854b: 174) was published on September 8, 1854, and must therefore be regarded as the original description of this species.

Hemilepidotus spinosus Ayres—reef Irishlord.
Hemilepidotus (?) spinosus Ayres, 1854a:166.

Cordell Bank vicinity, F50–9, 400 fathoms wire out (1 young, SL 21 mm., CAS 25639); ''Mulberry Seamount,'' F50–21, surface (2 postlarvae, SL 12 and 13 mm., CAS 25679).

In CAS 25639 the free fold of the gill membranes is extremely narrow at its middle. The interorbital is broad and flat, and the vertex is domed both longitudinally and transversely, suggesting the early juvenile characters of *Scorpaenichthys marmoratus.* There is a broad doubled spine at the end of the occiput, and the posttemporal spine is doubled. Each scale bears a single relatively large spinule slightly curved or inclined backward. There are 7 scale rows in the dorsal band near the head, with a trace of another developing along the base of the spinous dorsal. A row of embedded scales, which are hardly discernible except by their spinules, occurs in front of the caudal base, extends along the base of the anal fin, and joins a patch of similar scales in front of the anus (pl. 25).

The two young specimens of CAS 25679 have a convex interorbital and a strongly domed vertex. There is a longitudinally doubled spine at the end of the occiput. In lateral view, a smaller spine underlies the point of the posttemporal spine. In the smaller specimen the ventral row of spinules is just forming, and also the spinulose patch in front of the anus. The other scales are forming but their development is insufficient to afford a count of the rows (pl. 26). At first I regarded these two young specimens as *Hemilepidotus hemilepidotus,* and the record by Hanna (1951: 365) from this locality was based upon my determination. Further study, however, indicates that they are probably *Hemilepidotus spinosus.* Both have been compared with a specimen of *Hemilepidotus hemilepidotus* (CAS 25222), SL 26 mm., and with two specimens of *H. spinosus* (CAS 25221), SL 25 and 28 mm., which I collected May 23, 1947, at Trinidad Head, Humboldt County, California. All three from Trinidad have the row of spinuliferous scales connecting the posterior end of the main scale band with the spinulose patch across the belly in front of the anus, and running near the base of the anal fin and along the caudal peduncle just above its lower edge, but this row is exceedingly inconspicuous in the specimen of *H. hemilepidotus.* Each scale of the principal bands bears 2 relatively minute spinules in the specimen of *H. hemilepidotus* and in the 28-mm. *H. spinosus.* In the 25-mm. specimen the second spinule is just beginning to appear.

AGONIDAE—poachers

Xeneretmus triacanthus (Gilbert)—bluespotted poacher.

Cordell Bank, F49–12G, 124 to 80 fathoms (1 large young, SL 37 mm., CAS 25587).

LIPARIDIDAE—snailfishes

Nectoliparis pelagicus Gilbert and Burke—pelagic snailfish.

Cordell Bank vicinity, F50–14, 580 fathoms wire out (1 adult, SL 48 mm., CAS 25659).

In this specimen there are 7 principal caudal rays, rather than 6 as stated by Gilbert and Burke (1912: 82) or "four or six" as stated by Burke (1930: 190), and there are 5 rays in the lower lobe of the pectoral, rather than 3 or 4. The gill-rakers ($0 + 8—0 + 7$) are irregularly spaced, short, bifid, their points divergent. In life the distal portion of the caudal rays was vermilion, and there was a vermilion spot on the 2nd caudal ray and on the membrane above and below it, two-thirds of the distance toward its tip, and a vermilion spot on the distal portion of the membrane between the 5th and 6th caudal rays. The peritoneum appeared externally to be shining white, thickly covered with black dots.

STICHAEIDAE—pricklebacks

Chirolophis nugator (Jordan and Williams)—fuzzyhead prickleback.

Southeast Farallon Island vicinity, F50–A7, 44 to 33 fathoms (2 young, SL 16 and 21 mm., CAS 25635).

I follow Clemens and Wilby (1946: 178) in referring this species to the genus *Chirolophis* Swainson.

MOLIDAE—molas

Mola mola (Linnaeus)—common mola; fishermen's name, ocean sunfish.

Cordell Bank vicinity, F49–17 (1 half-grown, TL ca. 2 ft.).

This fish was observed under a crippled murrelet, which was swimming on the surface.

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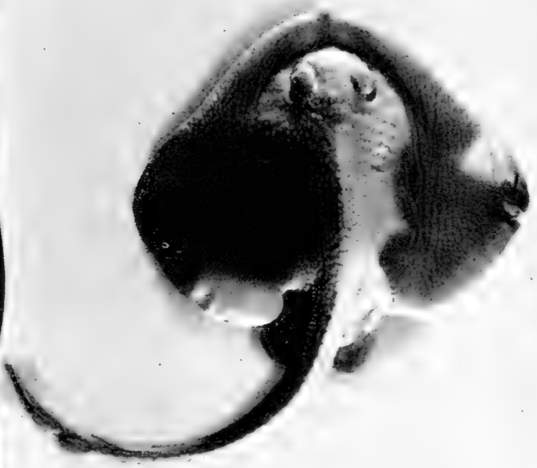
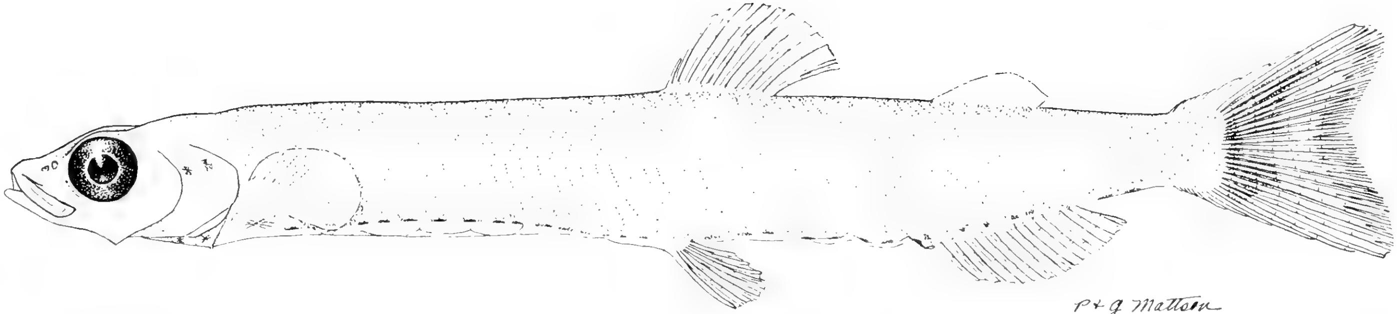


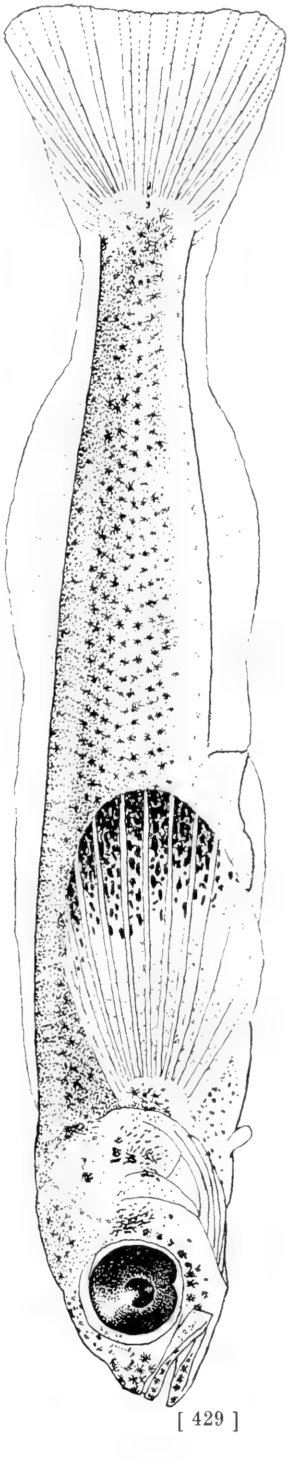
Figure 1. Egg-case of *Raja trachura*, CAS 25617, extreme length 210 mm., from "Mulberry Seamount," in 1,000 to 700 fathoms.

Figure 2. Embryo, CAS 25617, TL 185 mm., removed from the egg-case shown in figure 1.

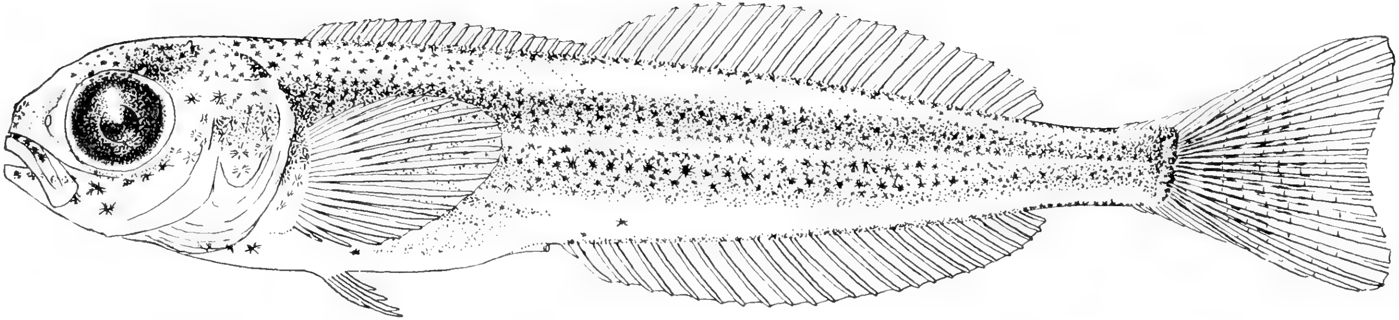


P+G Mattson

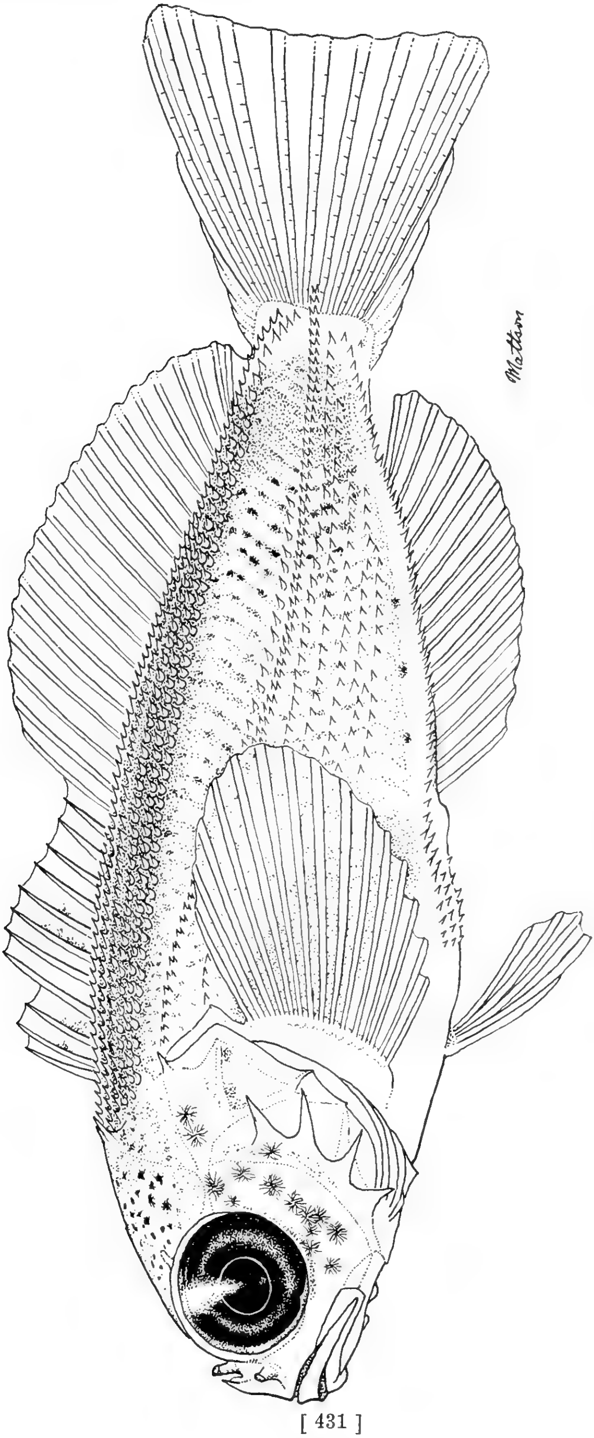
Postlarva of *Hypomesus pretiosus*, CAS 25634, SL 31 mm., from the vicinity of Southeast Farallon Island, in 44 to 33 fathoms.



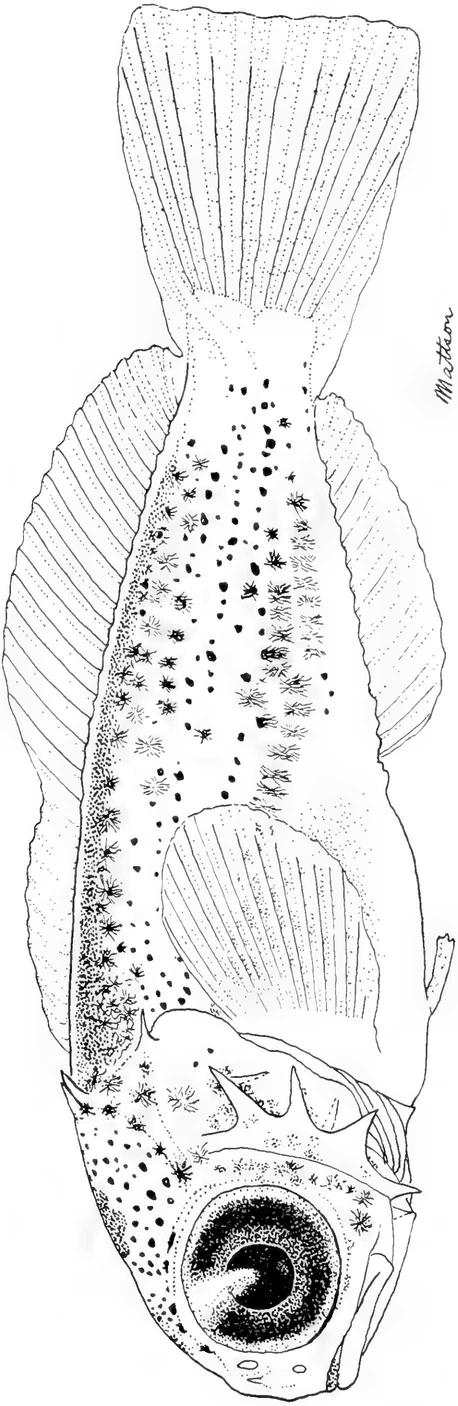
Postlarva of *Anoplopoma fimbria*, CAS 25678, SL 15 mm., from "Mulberry Seamount," at surface.



Postlarva of *Hexagrammos decagrammus*, CAS 25628, SL 25 mm., from off Waddell Creek, with 300 fathoms of wire out.



Young *Hemilepidotus spinosus*, CAS 25639, SL 21 mm., from vicinity of Cordell Bank, with 400 fathoms of wire out.



Postlarva of *Hemilepidotus spinosus* (?), CAS 25679, SL 12 mm., from "Mulberry Seamount," at surface.

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THE TORTOISE BEETLES OF CHINA (CHRYSOMELIDAE: CASSIDINAE)*

BY

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Pacific Science Board
National Research Council

INTRODUCTION

The tortoise beetles or gold beetles represent the subfamily Cassidinae of the large family Chrysomelidae (leaf or plant beetles) of the order Coleoptera. They are almost world-wide in distribution, though they have developed a much greater variety of types in the tropics, particularly tropical South America. They are scarce in certain temperate regions, particularly temperate North America and temperate Australia, though they are abundant in Europe and temperate Asia.

The Cassidinae are without exception leaf-feeding insects, both in the larval and adult stages. Moreover, they feed entirely on the surfaces of leaves, never mining between the outer leaf layers as do some of their relatives.

The subfamily is known for two characteristics in particular. One of these characteristics which is peculiar to the group is the possession in the larval stage (generally retained in the pupal stage) of a caudal appendage to which is attached the successive molted skins of the larva, and in turn, generally, accumulated larval feces. This structure, called the "parasol,"

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* Based on a thesis submitted in 1945 to the Graduate Division of the University of California in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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apparently serves as a protective device for the slow-moving, free-living larvae, and also for the sessile, likewise exposed, pupae, both by helping to hide and to arm these stages. The other particularly noteworthy characteristic, one almost limited to this group among all insects and present in most of the members of the subfamily, is a beautiful iridescence which is generally brilliant golden although it often includes other shades. This iridescence is present in life but lost in death. The possession of this characteristic is responsible for many of these beetles being classed among the most beautiful of living insects.

Scope: This study particularly concerns the Cassidinae inhabiting China and the adjacent islands. The purely taxonomic portion deals with the species of the subfamily thus far known from greater China, including Sinkiang, Mongolia, Tibet, Tsinghai, Manchuria, Hainan Island, and Taiwan, and also those known from the Ryukyu Islands, Korea, Japan, and Sachalin, since all of these areas are intimately related zoogeographically. The discussion of phylogeny, host-plant relationships, and distribution concerns the entire world.

Materials and methods: Collecting of adult specimens, and of some larval material, was done between 1929 and 1951 (Gressitt, 1936, 1937, 1940) in most of the areas treated in the taxonomic portion other than Sachalin, Korea, Manchuria, North China, and central Asia. Life-history work was done in Canton and Hong Kong between 1939 and 1942. The biological study concerned five species of three genera (four subgenera). Specimens have been studied from the collections of the following institutions: Lingnan Natural History Museum, California Academy of Sciences, United States National Museum, American Museum of Natural History, Museum of Comparative Zoology, Musée Heude of the Université l'Aurore in Shanghai, University of Nanking College of Agriculture, West China Union University, University of Amoy, Taiwan Agriculture Research Institute, Hong Kong University. Reports on some of the specimens collected have already been published (Gressitt, 1938 a-c; 1939; 1942). About 3,000 specimens have been studied, not counting many of those reared.

Types designated in the text as in the Lingnan Natural History Museum are temporarily on loan deposit in the California Academy of Sciences in San Francisco.

The life-history studies were made by rearing the beetles in petri dishes, small rearing cages, and glass jars with perforated aluminum covers. Leaves for food were added once or twice daily and kept fresh by means of small bits of wet cotton applied to the cut tips of the petioles. Most of the rearing was carried on in the insectary of the Lingnan Natural History Survey and Museum at Canton, although some was done on open porches in Canton and Hong Kong, all under reasonably normal conditions.

In the taxonomic treatment of the Chinese fauna, the higher categories are arranged systematically. The genera are first keyed, and under each generic heading is presented a key to the species or subgenera, together with the important generic characters. The species are arranged alphabetically under each genus.

Superscript numbers in the synonymy refer to geographical or host plant records listed under the pertinent headings below for the same species.

Romanizations of localities are often based on the pronunciation of the place-names in the dominant dialect of the particular region concerned, whereas romanizations of districts and provinces are according to the Mandarin pronunciation (Chinese official system).

Explanation of Special Anatomical Terms

Basal triangle: The basal area of each elytron bounded by a ridge from the suture behind the scutellum toward the basal margin between scutellum and humeral callus, generally an oblique extension of the second interpunctural area parallel to the suture.

Caudal furca (caudal process, feces fork): The forked terminal process of the abdomen of larva to which are attached the exuviae of the preceding instars.

Explanate margin: The frequently very broadly expanded margins of the pronotum, or of the elytra in adult beetles.

Frontoclypeal area: The main portion of the front of the head, bounded by the eyes, labrum, and antennal insertions.

Humeral angle (humerus): The basal and outer angle of the anterior portion of the explanate margin of an elytron.

Humeral callus: The swelling on the outer portion of the base of an elytron; located above the attachment of the hind wing.

Interpunctural areas (interspaces): The interspaces between the puncture-rows on the elytral discs. They are counted from the suture outward to the explanate margin.

Parasol: The combination of feces and larval exuviae, or the latter alone, attached to the caudal furca and held over the body.

Posterolateral portion or angle: The portion of an elytral explanate margin more or less half way between the middle of the side of the beetle and the sutural angles, or a more strongly curved portion in that area.

Puncture-rows: The longitudinal rows of punctures on the elytral discs counted from the suture outward.

Tarsal claws toothed: The tarsal claws are considered to be toothed when there is a more or less tooth-like process arising from the basal portion of each, not merely a slight swelling at the point of union and attachment of the two claws of each tarsus.

Explanation of Geographical Terms

Greater China: All of China, including Manchuria, Mongolia, Sinkiang (Chinese Turkestan), Tsinghai, Tibet, Hainan Island, and Taiwan.

Japan: The islands of Hokkaido, Honshu, Kyushu, and Shikoku.

Ryukyu Islands (Loochoo, Riukiu, Liu-kiu): The chain of islands between Japan and Taiwan, including Tanegashima, Yakushima, Amami-Oshima, Okinawa, Miyako, Ishigaki (Yaeyama), Iriomote, and Yonakuni, the last four forming the Sakishima group.

South China: The mainland portion of China south of the Yangtze River, including much of the headwater area of the latter; specifically, the southern portions of Kiangsu, Anhwei, and Hupeh provinces, and all of the provinces of Chekiang, Fukien, Kiangsi, Kwangsi, Hunan, Kweichew, Yunnan, Szechuan, Sikang, and mainland Kwangtung; this including West China and Southeast China.

Southeast China: The provinces of Chekiang, Fukien, Kiangsi, and Hunan, mainland Kwangtung, eastern Kwangsi, and the southern portions of Kiangsu and Anhwei.

North China: The portion of China proper north of the Yangtze River plus Manchuria, specifically the northern portions of Kiangsu, Anhwei, and Hupeh provinces, all of Manchuria, and the provinces of Shantung, Hopei, Honan, Shensi, and the southeastern portion of Kansu, and southern Inner Mongolia (Chahar, Suiyuan, and Ninghsia).

Central Asia: Outer Mongolia; the northwestern portions of Chahar, Suiyuan, Ninghsia, and Kansu; Tsinghai; Sinkiang (Chinese Turkestan); and northern Tibet (exclusive of Sikang).

West China: The provinces of Sikang, Szechuan, Yunnan, and Kweichow, and western Kwangsi.

List of Abbreviations

A.M.N.H.—The American Museum of Natural History, New York City.

C.A.S.—The California Academy of Sciences, San Francisco.

HKU.—The University, Hong Kong.

Lingnan—The Lingnan Natural History Museum, Lingnan University, Canton, China.

M.C.Z.—The Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.

Heude—Musée Heude, Université l'Aurore, Shanghai, China.

U.NK.—The University of Nanking (College of Agriculture).

U.S.N.M.—The United States National Museum, Washington, D. C.

W.C.U.U.—West China Union University (Biology Department), Chengtu, Szechuan, China.

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HISTORY

The family Chrysomelidae has had several great monographers, among them T. Lacordaire, F. Chapuis, and J. S. Baly. The most comprehensive work on the subfamily Cassidinae was done by C. H. Boheman (1854–1862). The most extensive worker in the group in recent years has been Franz Spaeth, who published the synopsis of Palearctic species (1926) in collaboration with Edmund Reitter. The only major work on Oriental species appeared in the Fauna of British India (Maulik, 1919).

Very little comprehensive work has been done on the tortoise beetles of China. Most of the species were described in scattered papers, nearly all by Europeans, particularly Boheman, Spaeth, Weise, and Baly, and many of them were originally described from areas apart from China, such as Siberia, Japan, India, or the peninsula of southeastern Asia. About 52 species were listed from China in two recent catalogs (Liu, 1936, and Wu, 1937), but these actually included only about one-half of the 91 species treated here, as a few of the former were based on erroneous records and a few were from the farthest borders of Chinese Turkestan and are omitted in this work. Since that time additional species have been recorded or described (Spaeth, 1936, 1938; Gressitt, 1938, 1939, 1942), and more are added herein.

SYSTEMATICS

The place of the Chrysomelidae in the Coleoptera: The family Chrysomelidae, in the broad sense, is one of the largest families of insects, being third in size within the order Coleoptera and including over 24,000 named species. The family is closely related to the large family Cerambycidae. These two families, together with the relatively small family Lariidae (Bruchidae; pea weevils), form the suborder Phytophaga or superfamily Cerambycoidea. This superfamily is placed highest among the beetles proper, before the suborder Rhynchophora, or weevils. One of the characters uniting these three families is the reduced fourth tarsal segment, which is visible only with high magnification in smaller species. Furthermore, the antennae are generally simple and slender, never clavate, lamellate, or geniculate, and the species are all phytophagous, feeding on leaves, stems, or wood of growing plants or in seeds or dead wood. The Lariidae are seed eaters, the Chrysomelidae are almost entirely leaf eaters, with some stem-boring or root-feeding forms, and the Cerambycidae are almost entirely wood borers.

The Chrysomelidae are generally distinguished from the Cerambycidae by their leaf-feeding, instead of wood-boring habits, their shorter and often dorso-ventrally compressed bodies, and in having the antennae rather flexible and generally shorter, instead of longer than the body. The Bruchidae are easily distinguished from the Chrysomelidae and the Cerambycidae by their very short, stumpy body, somewhat snoutlike head and beady or pectinate antennae.

The place of the Cassidinae in the Chrysomelidae: The Cassidinae form one of the largest subfamilies of the family Chrysomelidae, numbering over 3,000 named species. The subfamily is placed at the top of the scale within the family, as representing its peak of specialization. Chrysomelidae has been divided by various workers into several subdivisions, which by some are given family rank. Others have accorded each of the 16 subfamilies the rank of family. I believe that the whole should be retained as a single family, divided into six (or seven) subdivisions of a category intermediate between family and subfamily, as follows:

Group I: Orsodacninae, Sagrinae, Donaciinae, Criocerinae, Megascelinae, Megalopodinae.
Group II: Clytrinae, Cryptocephalinae, Chlamisinae.
Group III: Lamprosominae, Eumolpinae.
Group IV: Chrysomelinae.
Group V: Galerucinae, Halticinae.
Group VI: Hispinae, Cassidinae.

Chen (1940) made six families, taking the Criocerinae out of the first group to stand alone, and transferring the Lamprosominae from one group to go with the Clytrinae, Cryptocephalinae, and Chlamydinae. Both Chen and I (Gressitt, 1942) independently removed the Megalopodinae from the second group to my first group, and I set the subfamily Chrysomelinae to stand alone as a group. I further believe that the Orsodacninae may prove to represent a group apart from the first group.

Following is presented a key to the subfamilies of Chrysomelidae of the world. One of these subfamilies, Megascelinae, is not represented in the Old World. From the key it will be seen that the Cassidinae together with the Hispinae form a group widely separated by fundamental characters from the rest of the subfamilies. This suggests that they may have been the earliest group to diverge from the parent stock and continue to this day. Their divergence may have taken place at the beginning of the Triassic, or even in the Permian, since the Chrysomelidae and Cerambycidae are supposed to have separated or originated in the Carboniferous. The two subfamilies, though together widely separated from the rest of the Chrysomelidae, are not entirely suited to a distinct separation, at least on adult characters, and the larval habits and structures must be taken into account. The Neotropical genus *Himatidium* has been shuttled between the two.

KEY TO THE SUBFAMILIES OF CHRYSOMELIDAE

1\. Head with vertex projecting strongly forward and mouth directed posteriorly below and often partly hidden by prosternum; prothorax margined laterally; larvae dorso-ventrally flattened 2

— Head normal, with vertex not projecting forward and with mouth directed forward and downward 3

2.(1) Pronotum and elytra with broad marginal expansions, the former often covering head; larvae surface-feeders, bearing caudal appendages .... *Cassidinae*

— Pronotum and elytra rarely with broad marginal expansions, but often with spines; body generally slender if spineless; head never covered by pronotum; larvae generally leaf-miners, lacking caudal appendages .... *Hispinae*

3.(1) Antennae closely inserted on front of head; elytra not very rigid; anterior coxae contiguous, prominent; prothorax margined laterally; larvae free-living, root-feeding or leaf-mining, more or less cylindrical 4

— Antennae not very closely inserted, separated by frons or vertex; elytra generally somewhat rigid; only in the Clytrinae and a few Eumolpinae and Orsodacninae are both the anterior coxae contiguous and the prothorax margined laterally 5

4.(3) Posterior femora not greatly enlarged .... *Galerucinae*

— Posterior femora greatly enlarged for jumping .... *Halticinae*

5.(3) Eyes prominent and head more or less strongly constricted behind them; anterior coxae prominent and close, or fairly close; prothorax not completely margined laterally 6

— Eyes generally not very prominent and head not strongly constricted behind them; anterior coxae (except in Clytrinae) not close and not very prominent; prothorax usually completely margined laterally 11

6.(5) Posterior femora large and strongly swollen, often armed with teeth 7

— Posterior femora generally not greatly enlarged, rarely armed with teeth; exceptions have antennae not very widely separated 8

7.(6) Antennae long, with most segments longer than broad and cylindrical or bead-like; middle three abdominal segments no shorter than others; larvae bore in woody stems of leguminous vines .... *Sagrinae*

— Antennae short, barely reaching beyond humeri, distal segments generally broader than long, more or less dentate; middle three abdominal segments somewhat shorter than others .... *Megalopodinae*

8.(6) Antennal insertions separated by width of frons, fairly distant 9

— Antennal insertions not separated by width of frons, relatively close; antennae very slender; larvae generally live in stems of aquatic plants........ .... *Donaciinae*

9.(8) Tarsal claws simple, not toothed; prothorax cylindrical, never toothed laterally 10

— Tarsal claws generally bifid or toothed internally; prothorax frequently toothed or tuberculate laterally; larvae leaf-mining........ *Orsodacninae*

10.(9) Prothorax stout and often constricted near middle; head strongly narrowed behind eyes; deep oblique grooves meeting on vertex; antennae fairly stout; larvae free or stem-boring, bearing feces........ *Criocerinae*

— Prothorax slender, cylindrical, much narrower than elytra; head hardly narrowed behind eyes; no deep oblique grooves on vertex; antennae very slender; anterior coxae slightly separated; Neotropical, north to Texas........ .... *Megascelinae*

11.(5) Middle three abdominal sternites constricted in central portions; form of body subcylindrical; larvae case-bearers........ 12

— Middle three abdominal sternites not constricted; form of body more or less ovate or rounded, often strongly convex and constricted anteriorly........ 14

12.(11) Antennae relatively short and serrate; anterior coxae close and prominent, or antennae lodged in grooves in pro-pleura........ 13

— Antennae long and slender, not serrate and not lying in grooves; anterior coxae widely separated and not prominent........ *Cryptocephalinae*

13.(12) Prothoracic pleura without antennal grooves; body surfaces smooth; anterior coxae contiguous, prominent; larvae often in ant nests........ *Clytrinae*

— Prothoracic pleura with grooves for reception of antennae; body surfaces very rough or tuberculate........ *Chlamisinae*

14.(11) Wing venation not reduced; cubital veins present; clypeus not divided into two parts; body cylindrical, subspherical or deeper than wide........ 15

— Wing venation greatly reduced: cubital veins lacking; clypeus divided into two parts; body generally elongate-oval in dorsal outline and elliptical or semicircular in transverse section; larvae free-living, bearing feces........ .... *Chrysomelinae*

15.(14) Prothorax as broad as elytra basally, its sides grooved for reception of antennae; abdomen grooved for reception of hind legs; larvae are case-bearers .... *Lamprosominae*

— Prothorax generally narrower than elytra basally, its sides not grooved for reception of antennae; abdomen not grooved for reception of hind legs; larvae are root- and leaf-feeders, not case-bearers........ *Eumolpinae*

TAXONOMY OF THE CASSIDINAE

The taxonomy of the tortoise beetles is difficult as compared with that of many other groups of beetles. Variation within a species is rather great, and reliable constant characters are rather few. One of the most obvious stumbling blocks for workers in this group is associated with the peculiar nature of coloration in these beetles. The color, as mentioned above, is generally of an ephemeral nature. It is the result of a combination of structural and functional effects, involving both reflection of light rays from numerous semitransparent or completely transparent layers in the cuticle, and the presence of body fluid between the minute layers (Mason, 1929; Onslow, 1921). This fluid requirement is lost with desiccation following death and the iridescence disappears. Variation in color occurs even in life because these beetles have the ability to change the degree of brilliancy of the iridescence by widening or narrowing the separation of the layers of cuticle, accomplished by added or lessened pressure of fluid in the epidermal region. In many types, by soaking dried specimens in water or even in alcohol in some cases, the original golden iridescence can be re-attained to a greater or lesser degree, but only to be lost again with re-desiccation. Apparently both differences in method of killing and preserving and rate or extent of desiccation of specimens are responsible for great differences which so frequently exist between dried specimens of a species taken at the same time and place. These differences involve the range from complete transparency to complete opacity of the cuticle and seem to suggest great differences in precipitation of solid material from the body fluid between the layers of the cuticle. These variations are no doubt dependent at least in part on the physiological state at the time of death, particularly as regards amount of fatty tissue present.

Permanent pigmentation, such as black markings, generally occurs among the outermost layers of the cuticle, whereas the clouding effect of the above-mentioned precipitation often occurs farther from the surface of the cuticle. The variation in degree of precipitation, besides changing the general appearance and color of the insect, further aids confusion in taxonomy by causing punctures to appear much larger or smaller than they actually are, and ridges or borders to appear higher, lower, thinner, or thicker than is actually the case. When opacity is complete, punctures appear much smaller than they do when the cuticle is transparent.

In the explanate margins partial precipitation of opaque material within almost invariably produces a reticulated effect of opaque lines, varying in every degree of thickness from practical invisibility to complete opacity except for minute transparent punctures, and further to the complete extremes mentioned above. When the margins are punctured, the reticulations form around the punctures. The effect on the pronotal and elytral discs is similar, but less conspicuous. From these remarks it will be seen that ''explanate margins reticulate,'' or similar statements, are worthless as far as classification is concerned.

In addition to the type of color mentioned above, some cassidids have permanent metallic and iridescent coloration of the strictly structural type, which remains unchanged in death. Some are partially permanently metallic and partially endowed with ephemeral colors, that is on different parts of the body.

Secondary sexual dimorphism occurs in the cassidids, but is more pronounced in the more primitive groups and rather slight in the more advanced types. It generally involves differences in the length and thickness of the antennae, and the shape of the pronotal and elytral explanate margins.

Wing venation as a taxonomic character is not of great use within the subfamily, and the same is true of genitalic morphology.

THE CHINESE CASSIDINAE

I have assigned the known Chinese tortoise beetles to 93 forms, belonging to 91 species, arranged in 15 genera of 3 tribes. Nine species and two subspecies are herein described as new to science. One new subgenus is also proposed. Three older generic names are substituted for those hitherto commonly used, and two of these involve changing the tribal or subtribal names concerned. Another genus is reduced to synonymy, and a number of new subgeneric assignments are made. Thus nearly one-half of the species discussed are given newly arranged names, at least in the subgeneric sense.

I believe that the following names, as recorded from China, or Japan, are either misidentifications or are based on mistaken locality labels associated with the specimens:

Prioptera pallida Wagener, Spaeth.
Glyphocassis trilineata (Hope), Liu.
Chirida promiscua (Boheman), Spaeth.
Metriona versicularis (Thunberg).

The following species have been recorded from the far borders of China, and are not discussed in this work:

Cassida moori Boheman; "Turkestan."

Cassida nigriventris Boheman; "Tibet"—probably the Brahmaputra River valley in southernmost Tibet.

Cassida turcmenica Weise; Dsungarei (northwestern Sinkiang).

Cassida undecimnotata Gebler; Tian Shan (Tien Shan, northwestern Sinkiang).

The Chinese record of *Cassida catenata* (Boheman) is referred to under *Cassida circumdata* Herbst, below.

Cassida (Cassidula) nobilis Linnaeus and *C. (C'la) vittata* Villers were recorded from Japan (Chujo, 1934) on the basis of interpreting the German abbreviation for "excluding" Japan, as including it, in the distribution recorded in the Coleopterorum Catalogus (Spaeth, 1914-c). However, the latter species was cited from Kyoto, Japan, in another work (Spaeth, 1914-d).

Synoptic Discussion of Genera and Species

Key to the Genera of Chinese Cassidinae

1.	Head visible from above, not covered by pronotum *(Basiprionotini)*	2
—	Head not visible from above, covered by pronotum	7
2.(1)	Vertex not produced anteriorly; elytral margins narrow at bases; pronotum grooved laterally	3
—	Vertex strongly produced into a forward projecting plate above antennal insertions; pronotum very broad, lacking submarginal grooves	*Notosacantha*
3.(2)	Pronotal and elytral margins broadly or moderately expanded; anterior margin of pronotum deeply and arcuately or very broadly emarginate; elytra non-metallic, in large part shallowly and irregularly punctured	4
—	Pronotal and elytral margins narrowly expanded; anterior margin of pronotum feebly emarginate; elytra metallic or partly so, very deeply and subseriately punctured	5
4.(3)	Pronotal and elytral margins quite broad, latter widened in middle; prothoracic margins deeply emarginate anteriorly, borders not particularly thickened	*Basiprionota*
—	Pronotal and elytral margins not very broad, latter hardly widened in middle; prothoracic margins broadly and shallowly emarginate apically, borders thickened	*Stenoprioptera*
5.(3)	Body oblong-ovate	6
—	Body strongly broadened and rounded posteriorly; scutellum triangular	*Megapyga*
6.(5)	Pronotum grooved medially and nearly impunctate, its anterior margin obtusely emarginate; elytra entirely metallic, iridescent	*Craspedonta*
—	Pronotum coarsely punctured, not grooved medially, its anterior margin broadly and transversely emarginate; elytra only partially metallic	*Epistictia*
7.(1)	Tarsal claws bearing a comblike structure at base *(Aspidomorphini)*	8
—	Tarsal claws lacking a comblike structure at base *(Cassidini)*	11
8.(7)	Comblike structure present on both sides of tarsal claws	9
—	Comblike structure present on inner side of tarsal claws only	*Sindia*
9.(8)	Body somewhat triangular or pentagonal in outline, fairly deep; elytra rugulose and deeply punctured, with moderately broad, declivitous lateral expansions	10
—	Body rounded in outline, depressed; elytra fairly smooth, with broad, subhorizontal lateral expansions	*Aspidomorpha*
10.(9)	Comblike structures long on both sides of tarsal claws	*Sindiola*
—	Comblike structures short on outer sides of tarsal claws	*Laccoptera*
11.(7)	Prosternum lacking a groove on each side for reception of antennae	12
—	Prosternum with a groove on each side for reception of at least basal portions of antennae	13
12.(11)	Apical margins of elytra lacking a row of fine hairs on undersides; claws often toothed basally	*Cassida*

— Apical margins of elytra with a row of fine hairs on undersides; tarsal claws lacking basal teeth or appendices .... *Thlaspida*

13.(11) Tarsal claws not appendiculate basally, or feebly so 14

— Tarsal claws strongly appendiculate basally; last two antennal segments projecting beyond posterior margin of prothorax; antennae slender; body very deep .... *Chiridopsis*

14.(13) Antennae hardly reaching beyond posterior margin of prothorax 15

— Antennae with distal two or three segments extending beyond posterior margin of prothorax; second and third segments subequal in length; pronotum transversely elliptical; explanate margins of elytra not very steeply declivitous; body moderately convex .... *Glyphocassis*

15.(14) Third antennal segment shorter than second; body deep; pronotum triangular; explanate margins of elytra steeply declivitous .... *Ischyronota*

— Third antennal segment as long as second; elytra each with four longitudinal ridges (not yet recorded from China) .... **Hypocassida*

Tribe **BASIPRIONOTINI**, new name

Priopterini of authors.

Pronotum emarginate anteriorly, exposing at least part of head. Antennae fairly stout.

Subtribe **NOTOSACANTHINA**

Hoplionotites LACORDAIRE, 1875, Gen. Col., 11:357.

Head produced anteriorly above antennal insertions. Antennae slender basally and thickened distally into a slender club.

Genus **Notosacantha** Chevrolat

Notosacantha CHEVROLAT, 1837, in Dejean, Cat. Col., ed. 3:367, 391; BARBER & BRIDWELL, 1940, Bull. Brookl. Ent. Soc., 35:7.

Hoplionota HOPE, 1840, Col. Man., 3:153; GUERIN, 1844, Icon. Regne Anim. Ins., 2:287; BOHEMAN, 1850, Mon. Cassid., 1:16; CHAPUIS, 1875, Gen. Col., 9:357; WAGENER, 1881, Mitt. Münch. Ent. Ver., 5:21; SPAETH, 1913, Verh. Zool.-Bot. Ges. Wien, 63:381; 1914, op. cit., 64:290; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 284.

Head produced anteriorly between eyes into a more or less flat or concave plate, extending well beyond eyes and often broadened distally. Frons longer than broad, concave. Antennae very slender basally, thickened in distal portion. Pronotum generally more than twice as broad as long, deeply emarginate at middle of anterior portion, exposing most of dorsal surface of head to view from above. Elytra about as broad as pronotum, often somewhat rectangular, generally rough and tuberculate on discs. Explanate margins of pronotum and elytra broad, deeply punctured. Legs short and flattened; tarsi short and broad, hairs of third segment extending far beyond claws. This genus contains nearly 200 species, almost one-half of them from Madagascar, and the rest largely from South Africa and the Oriental region.

Generotype: *Cassida echinata* Fabricius (Madagascar).

Range: Ethiopian, Oriental, and Australian regions.

Key to the Chinese Species of Notosacantha

1. Anterior process of head narrowed distally or nearly obsolete 2

— Anterior process of head broadest near apex, truncate or convex apically 4

2.(1) Anterior process of head distinct, narrowed distally, cleft in middle 3

— Anterior process of head nearly obsolete, blunt and not flattened, feebly cleft at middle of apex; elytral ridges and tubercles very high; anterior inner tubercle laterally compressed and posterior tubercle acute .... *N. castanea*

3.(2) Body subrounded, brown, with a broad "window" at middle of each side; pronotal margin even anteriorly .... *N. fumida*

— Body suboblong, black, with a narrow "window" at middle of each side; pronotal margin subserrate anteriorly .... *N. sinica*

4.(1) Body outline suboblong; prothorax practically as broad as widest part of elytra 5

— Body outline subrounded; prothorax distinctly narrower than widest portion of elytra; punctures of pronotal expansions elliptical or round 7

5.(4) Prothorax about three times as broad as long; punctures on explanate margins of pronotum not all oblong in shape; each elytron with a "window spot" 6

— Prothorax barely more than twice as broad as long; punctures on explanate margins of pronotum oblong; each elytron with a longitudinal ridge parallel to suture, with a few short branches, but lacking tubercles and lateral "window spots" .... *N. oblongopunctata*

6.(5) Each elytral disc with many small tubercles or nodes .... *N. centinodia*

— Each elytral disc with three sharp major tubercles connected by some distinctly raised reticulate ridges .... *N. trituberculata*

7.(4) Anterior process of head somewhat rounded apically, feebly cleft at middle 8

— Anterior process of head truncate apically, emarginate at middle; pronotal and elytral margins testaceous .... *N. marginalis*

8.(7) Disc of each elytron with a few small tubercles and a median longitudinal ridge posteriorly .... *N. arisana*

— Disc of each elytron with three low tubercles and two ridges on posterior portion which meet to form a right angle .... *N. sauteri*

Notosacantha arisana (Chujo), new combination

Hoplionota arisana Chujo, 1934, Sylvia, 5:148[1]. (Type in Taiwan Agricultural Research Institute.)

Dorsal surfaces dark reddish brown; explanate margins paler, those of elytra each with a pale yellowish spot before middle; head, thoracic sterna, and legs red-brown; abdomen yellow-brown; antennae brownish basally, duller distally.

Dorsal outline subrounded; moderately convex. Head with anterior process broadened distally, with apical margin convex and briefly cleft at middle. Pronotum two and one-half times as broad as long, granulose; disc with two depressions and two oblique grooves; explanate margins with fairly large transparent punctures. Elytra barely broader than prothorax basally, much wider in middle; disc of each with small scattered tubercles and a submedian carina behind center; suture raised beyond a fovea on each behind scutellum. Length 5 mm.; breadth 4 mm.

China: Taiwan (Arisan[1]).

Distribution: Taiwan.

Notosacantha castanea (Spaeth), new combination

Hoplionota castanea Spaeth, 1913, Verh. Zool.-Bot. Ges. Wien, 63:507[1]; 1933, Wiener Ent. Ztg., 50:126[2]. (Type in Spaeth collection.)

Dorsal surfaces castaneous brown, slightly darker along suture; window-spot of each elytral margin brighter, feebly transparent; ventral surfaces reddish yellow. Head with anterior process narrowed before eyes, acute apically; pronotum two and one-half times as broad as long, narrowed at sides toward basal angles, smooth and shiny on disc, with a broad, punctate basal impression and an incomplete median transverse impression, and punctured on margins; elytra slightly longer than broad, subtruncate apically, coarsely seriate-punctate on discs which bear several irregular ridges and fairly sharp tubercles, coarsely punctured on explanate margins. Length 5.5 mm.; breadth 4.8 mm.

China: Taiwan[2].

Distribution: North Indo-China[1]; Taiwan.

Notosacantha centinodia (Spaeth), new combination

Hoplionota centinodia Spaeth, 1913, Verh. Zool.-Bot. Ges. Wien, 63:514[1]; 1933, Wiener Ent. Ztg., 50:128 (synopsis). (Type in Spaeth collection.)

Head and antennae yellow; pronotum pitchy black with yellow spots near head and basal margin partly brown; scutellum black; elytra brown, a bright pale spot on each humerus, a yellowish-white window-spot on each explanate margin, tubercles black and suture and extreme apices yellow; ventral surfaces reddish yellow with metasternum black.

Dorsal outline subrectangular; feebly constricted between pronotum and elytra. Head with interocular process short, feebly broadened distally, truncate and narrowly emarginate apically. Pronotum three times as broad as long, narrowed to posterolateral angles, finely punctured on depressed areas of disc. Elytra broadest anterior to middle, feebly narrowed posteriorly, as long as broad; disc of each with many small tubercles, principal posterior one not very high; explanate margins rugulose punctate except on window-spot. Length 4.5 mm.; breadth 3.8 mm.

China: Yunnan[1].

Distribution: Southwestern China.

Notosacantha fumida (Spaeth), new combination

(Plate 27, figure 2)

Hoplionota fumida SPAETH, 1913, Verh. Zool.-Bot. Ges. Wien, 63:513[1]; 1933, Wiener Ent. Ztg., 50:131; GRESSITT, 1938, Lingnan Sc. Jl., 17:573[2]. (Type in the British Museum.)

Pitchy black to reddish brown above; explanate margins narrowly ochraceous at borders, that of each elytron with a large pale yellow translucent spot anterior to middle; ventral surfaces pitchy with abdomen and legs dull testaceous.

Rounded-oblong in dorsal outline; nearly as broad as long; dorsum relatively even. Cephalic process narrowed apically, deeply and narrowly emarginate. Pronotum impressed with elongate punctures at sides, convex and sparsely punctured in middle; scutellum broad, rounded posteriorly; elytra incomplete, feebly raised at three points, with four ridges radiating from third tubercle; explanate margins more strongly punctured, but impunctate on inner halves of translucent areas. Length 5–6.5 mm.; breadth 4.2–5.4 mm.

China: N. Kwangtung[2] (Yao Shan, Lien Distr.); Hong Kong (?).

Distribution: South China[1].

Notosacantha marginalis (Gressitt), new combination

(Plate 27, figure 1)

Hoplionota marginalis GRESSITT, 1942, Lingnan Nat. Hist. Surv. & Mus. Spec. Publ., 5:1, fig. 1[1]. (Type in Lingnan Museum.)

Dorsal surfaces dull red-brown to pitchy on pronotal and elytral discs and scutellum, paler pinkish red on lateral expansions with extreme margins testaceous; ventral surfaces pitchy brown, black on meso- and metasterna; antennae reddish ochraceous, golden pubescence on clubs.

Head with interocular process concave, slightly broader apically than basally, emarginate in middle and rounded at corners; antenna with last five segments broadened and compressed; scape longer than following two segments united. Prothorax two and one-half times as broad as long; basal margins evenly rounded; anterior emargination trapezoidal; disc unevenly convex, slightly raised posteriorly along middle, opaque, almost granulose at sides; explanate margins somewhat shiny, with large oval or subrounded punctures and a single row of small round punctures near borders. Scutellum broadly rounded posteriorly, finely punctulate. Elytra broad, evenly rounded laterally and posteriorly, just as broad at extreme base as prothorax; disc of each with small swellings on extreme base, humerus, third interpunctural area near base and before middle, the same carinate at beginning of apical declivity and feebly so before apex, an obliquely transverse ridge curving outward to middle of lateral margin from anterior end of postmedian longitudinal carina; surface seriate-punctate; explanate margins sparsely and irregularly impressed with coarse rounded or oblong punctures. Ventral surfaces micropunctulate; frons concave with a narrow median carina. Length 4.7–4.8 mm.; breadth 4.1–4.2 mm.

China: Northern Kwangtung (Lien-ping Distr.[1]). April.

Distribution: South China.

Notosacantha oblongopunctata (Gressitt), new combination

(Plate 30, figure 1)

Hoplionota oblongopunctata GRESSITT, 1938, Lingnan Sc. Jl., 17:573[1]. (Type in Lingnan Museum.)

Pitchy red-brown mixed with blackish on pronotal and elytral discs; explanate margins yellowish testaceous, tinged with reddish on sides of pronotal expansions and on posterolateral portions of elytra; ventral surfaces and legs reddish testaceous, duller on metasternum; antennae ochraceous.

Body rounded oblong in form, slightly over three-fourths as broad as long. Interocular process truncate apically, broader at apex than at base, narrowly and briefly emarginate at middle, not extending as far anteriorly as margins of pronotum, grooved between eyes. Pronotum practically as broad as elytra at base, rather evenly rounded from anterior emargination (which is near V-shaped) to posterolateral angles; anterior margin with fine, close serrations; disc fairly smooth; explanate margins with large deep oblong punctures. Elytra as broad as long, broadly rounded posteriorly, subparallel; discs shallowly punctured, subseriately so only at sides, inner costa prominent, interrupted at intervals, with two branches; explanate margins with deep, oblong, subseriate punctures. Length 4.2–4.4 mm.; breadth 3.1–3.3 mm.

China: Hainan Island (Sam-ah-kong[1]). January.

Distribution: Hainan Island.

Notosacantha sauteri (Spaeth), new combination

Hoplionota Sauteri SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64:295[1]; 1933, Wiener Ent. Ztg., 50:124; CHUJO, 1934, Sylvia, 5:149[2]. (Type in Spaeth collection.)

Dorsal surfaces pitchy red-brown, almost black on pronotal disc; explanate margins of pronotum and elytra pale blood-red, becoming ochraceous near outer borders; ventral surfaces pitchy black on thoracic sterna and ochraceous on abdomen; head reddish brown; antennae testaceous; legs reddish, darker basally.

Dorsal outline rounded-oblong, broadest near middle. Head with interocular process flat, broadly rounded apically. Pronotum slightly broader than elytra at extreme bases; explanate margin with oval or rounded punctures, feebly serrate margins and rounded anterolateral angles. Elytra rather evenly rounded to sutural angles; disc of each with an interrupted ridge in the third interpunctural area connecting with a subtransverse ridge just behind middle. Length 4.5 mm.; breadth 3.85 mm.

One (C.A.S.) Suisharyo, altitude 1100 meters, near Arisan, June 10, 1932, Gressitt.

China: Taiwan (Fuhosho[1], Koshun[2], Suisharyo).

Distribution: Taiwan.

Notosacantha sinica Gressitt, new species

(Plate 30, figure 2)

Largely black: head pitchy brown beneath; antennae pitchy black distally, reddish on basal segments; prothorax black above, pitchy beneath, with external margin narrowly amber; scutellum black; elytra black with borders amber, more widely so near sutural angles and with a narrow pale "window" on each explanate margin just anterior to middle, broadened at external margin; ventral surfaces pitchy black, paler to reddish brown on sides of abdominal sternites; legs pitchy, nearly black on femora.

Head with anterior process narrowed and subrounded apically, narrowly emarginate at middle of apex, somewhat flattened and depressed, with a raised margin bordering eyes and occiput raised on each side near margin of pronotum; frons with an oblique depression on each side. Antenna not reaching side of pronotum, slender basally, thickened and flattened in last five segments; scape stout; second segment slightly longer, and much thicker, than third. Prothorax nearly three times as broad as long, anterior emargination somewhat trapezoidal; external margin somewhat serrate, particularly near emargination; disc with three moderate depressions on each side, and some punctures of various sizes, mostly small; explanate margin somewhat frosted, with large round or oval punctures. Scutellum rounded-trapezoidal, convex and finely corrugated. Elytra somewhat broader than prothorax, roughly squarish, rounded ectoapically, broadened behind humeri; disc of each sinuous in lateral outline, somewhat steeply declivitous posteriorly; first costa incomplete in middle, but represented by a low basal crest, a higher tubercle behind middle where costa is crossed by a subtransverse ridge, and raised again, with a short subtransverse ridge, at top of posterior declivity; second costa less complete, represented by humeral swelling, a very small tubercle behind and external to basal crest of first costa, and two small posterior tubercles, respectively external and posterior to last two tubercles of first costa; disc otherwise with partially regular rows of fairly close punctures; explanate margin with punctures of various sizes, mostly large, and with a thickened ridge a short distance from external margin; border very feebly serrate. Ventral surfaces finely striolate on metasternum and finely punctured or frosted on abdomen. Femora relatively long and slender. Length 4.8 mm.; breadth 4 mm.

Holotype (Lingnan Natural History Museum), **Ta-chu-lan, Shaowu,** altitude 1,200 meters, **northwestern Fukien Province, Southeast China,** April 25, 1943, T. Maa (Maa Tsing-chao).

Differs from *N. fumida* (Spaeth) in being smaller, more rectangular, largely black, with the pronotum more serrate anteriorly and with the explanate margins with more rounded punctures and the elytra more costate and tuberculate, with a narrower transparent "window" on side of each.

Distribution: Southeast China.

Notosacantha trituberculata Gressitt, new species

(Plate 30, figure 3)

Dorsal surfaces largely reddish brown; pronotal and elytral discs pitchy black tinged with reddish brown, particularly on swollen areas of former and sides of latter; explanate margins reddish brown, paler on pronotum near head and pronotal disc, and on each elytron at extreme apex and on an oval, subtransparent area at middle of each side, adjacent to disc; ventral surfaces and legs pale reddish testaceous, slightly darker on head.

Dorsal outline suboblong, slightly irregular at sides and sinuate anteriorly and posteriorly. Head with interocular process moderately short, slightly broadened distally and feebly convex on apical margin. Antenna not reaching side of pronotum; slender basally, much thicker distally. Pronotum nearly three times as broad as long, narrowed at sides, rounded at anterolateral angles, finely serrate on margins; disc irregularly punctured, an arcuate, largely impunctate raised band near base; explanate margins with moderately large rounded oval punctures. Elytra slightly broader than pronotum, widest in central portion, narrowed at humeri, rounded posteriorly; disc of each coarsely subseriate-punctate, puncture-rows interrupted by ridges and tubercles; three major tubercles, first near base and fairly close to suture, second slightly behind middle and third at top of posterior declivity, each equidistant from suture and connected by a slightly irregular longitudinal ridge, another less regular longitudinal ridge connecting lateral ridges from tubercles along middle of disc; explanate margin widest at end of basal third, impressed with deep punctures of irregular shapes which are sparser on hyaline spot. Length 5 mm.; breadth 4.2 mm.

Holotype (California Academy of Sciences), **Rokki** (Rokkiri), altitude 350 meters, **near Kizan, southwestern Taiwan,** May 14, 1934, Gressitt.

Differs from *Notosacantha horrifica* (Boheman), new combination, from Ceylon, in having the pronotal margins evenly rounded anterolaterally and more transverse anteriorly, and the elytral discs less strongly raised postmedially, with the posterior tubercles no more than twice as high above surfaces of discs as anterior tubercles.

Distribution: Taiwan.

Subtribe **BASIPRIONOTINA**

Genus **Craspedonta** Chevrolat

Craspedonta CHEVROLAT, 1837, in Dejean, Cat. Col., ed. 3:391.

Calopepla HOPE, 1840, Col. Man., 3:152; BOHEMAN, 1950, Mon. Cassid., 1:8; CHAPUIS, 1875, Gen. Col., 11:370; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 306; new synonymy.

Head short, outline round in anterior view, well retracted into prothorax; frons broad, scutiform. Antennae stout; in male nearly as long as width of pronotum, with basal segments flattened and broadened distally, apical segments flattened and parallel-sided; in female barely two-thirds as long as width of pronotum, with basal segments relatively slender and subcylindrical, apical segments flattened. Pronotum transverse, obtusely emarginate anteriorly, barely exposing part of head; disc medially grooved; margins narrow, reflexed, of equal width throughout. Elytra much longer than broad, somewhat wider than pronotum, very narrowly margined, dentate on basal margin, coarsely punctured and rugose. Prosternum broad and flat, rounded posteriorly. Legs stout; tarsal claws large, untoothed, extending beyond lobes of third segment.

The genus contains but four or five species. I am indebted to the late Mr. H. S. Barber for calling my attention to the older valid name for the genus.

Generotype: *Imatidium leayanum* Latreille (India).

Range: Most of Oriental Region.

Craspedonta leayana insulana (Gressitt), new combination

(Plate 27, figure 8)

Calopepla leayana subsp. *insulana* GRESSITT, 1938, Lingnan Sc. Jl., 17:187[1]; 574[2]. (Type in U.S.N.M.)

Pronotum and scutellum ochraceous and translucent to opaque cream-color or reddish; elytra brilliant metallic golden-green to blue-green; ventral surfaces ochraceous; head partly pitchy; antennae black on distal four and two-thirds segments; tarsi black.

Pronotum minutely punctulate, deeply grooved medially, a fovea on each side of middle of base. Scutellum longer than broad. Elytra nearly one-half again as broad as pronotum, deeply subseriate-punctate with most of interspaces costate and with some transverse rugae. Length 11–13.5 mm.; breadth 6.8–8 mm.

Host: The typical form feeds on *Gmelina arborea* Roxb. in Burma. This subspecies was taken feeding on a small tree which is very likely the same species, or a member of the same genus.

China: Hainan (Ta-hau, Ta-hian, No-kyu-chun, Nga-hon-tung[1], Cheung-kon, Tai-pin, Tai-tsing-lam[2]). March to July.

Distribution: Hainan Island.

Genus **Megapyga** Boheman

Megapyga BOHEMAN, 1850, Mon. Cassid., 1:40; CHAPUIS, 1875, Gen. Col., 11:369.

Prothorax feebly emarginate anteriorly; head visible from above; body strongly broadened and rounded posteriorly; explanate margins of elytra very narrow; elytra metallic or partly metallic, deeply and subseriately punctured.

China is somewhat outside of the expected zoogeographical range of the genus, as far as the known distribution of the species is concerned.

Generotype: *Megapyga coeruleomaculata* Boheman (Philippines).

Range: Malay Archipelago; Philippine Islands; China.

Megapyga chinensis Spaeth

Megapyga chinensis SPAETH, 1936, Proc. Roy. Ent. Soc. London, B, 5:81. (Type in British Museum.)

Elytra metallic blue; prothorax reddish yellow with an anteriorly narrowed black median line; occiput and scutellum black; ventral surfaces, legs (with exception of the black tarsi), the scape entirely, and the undersides of the following three antennal segments, reddish yellow.

Very similar to *M. eximia* Boheman, with much coarser puncture-rows on the unicolorcus blue elytra, shorter prothorax, thicker margins of prothorax and elytra; the sides of the prothorax run in a straight line without emargination to the anterior corners. Length 7 mm.; breadth 5.25 mm. (After Spaeth).

China: Cho-Ganh[1]. August.

Distribution: South China.

Genus **Epistictia** Boheman

Epistictia BOHEMAN, 1850, Mon. Cassid., 1:12; CHAPUIS, 1875, Gen. Col., 11:371; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 318.

Head very short, transversely rounded oval; mouthparts not retracted into prothorax; clypeus nearly three times as broad as long, chevron-shaped; eyes slender, elliptical. Antennae stout, compact, cylindrical basally and compressed and broadened distally, segments parallel-sided, about as long as width of pronotum in male and somewhat shorter in female. Pronotum transverse, trapezoidal, broadly and shallowly emarginate apically, exposing part of head, narrowly margined laterally. Scutellum transversely semicircular. Elytra oval, as broad as pronotum basally, coarsely punctured. Metasternum broad, rounded posteriorly. Tarsi broad; claws simple and reaching beyond lobes of third segment.

Generotype: *Epistictia viridimaculata* Boheman (India to Malaya).

Range: Oriental region.

Epistictia viridimaculata Boheman

Epistictia viridimaculata BOHEMAN, 1850, Mon. Cassid., 1:151[1]; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 320, fig. 99[2]; CHEN, 1935, Sinensia, 6:780[3], fig. 6; GRESSITT, 1938, Lingnan Sc. Jl., 17:576[4]. (Type in Geneva Museum.)

Epistictia perplexa BALY, 1863, Jl. Ent., 2:7[5].

Epistictia Parryi BALY, 1863, l.c.:8[6].

Epistictia marginata KIRSCH, 1875, Mitt. Zool. Mus. Dresden, 1:56[7].

Epistictia viridimaculata var. *collaris* WEISE, 1897, Deutsche Ent. Zeits. 1897:99[8].

Dorsal surfaces brick-red to blood-red; pronotum with a metallic greenish spot on each side of disc near base; each elytral disc with seven similar spots of varying sizes arranged somewhat in zig-zag fashion; lateral margins of pronotum translucent and amber colored; antennae black except for first two or three segments which are reddish; mesepisternum blackish.

Dorsal outline subovate; body not very strongly convex. Pronotum deeply punctured on disc, densely so except near center, evenly narrowed and slightly convex at sides. Elytra deeply and densely punctured, irregularly so beyond raised second interspace; margins very narrow. Length 6.8–11.5 mm.; breadth 4.6–6.7 mm.

China: Kweichow[3]; Kwangsi (Lung-chow[4]).

Distribution: India (Nepal[1]); Assam[2,6]; Burma[2,8]; Southwestern China; Indo-China[5]; Siam[2]; Malacca[7].

Genus **Stenoprioptera** Spaeth

Stenoprioptera SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (132).

Explanate margins of prothorax narrow, with thickened borders; prothorax broadly and shallowly emarginate anteriorly, where the borders are less thick; corners at anterior emargination obtusely angulate; explanate margins of elytra narrow, hardly widened in middle, forming a narrow strip posteriorly, thickened on the borders; prosternum feebly broadened posteriorly, lacking impressions.

Orthogenerotype: *Stenoprioptera tibetana* Spaeth (Yunnan; Tibet).

Range: Western China.

Stenoprioptera tibetana Spaeth

Stenoprioptera tibetana SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (132[1]). (Type in Manchester Museum.)

Narrowly ovate, swollen, slightly shiny; ventral surfaces, legs, antennae, scutellum and occiput black; head reddish; prothorax and elytra yellow, black on basal teeth and posterior extremity of suture and with three black spots on each: (1) round, on humeral swellings, (2) round, behind middle near suture, (3) transverse, bar-shaped, posteriorly on the expanded margin. Antennae as in *Basiprionota,* thick, cylindrical, elliptical in cross-section distally, no distinct division between basal and distal segments, basal segments with isolated round punctures, distal segments successively wider, with longitudinal ridges; third segment shorter than second, fourth longer than other basal segments. Pronotal disc swollen, with a fine, impressed median line and obsolescent puncturation; basal margin twice deeply sinuate. Elytra closely meeting prothorax basally, broadened posteriorly in a straight line on each side to behind middle, broadly rounded posteriorly; discs moderately swollen, coarsely, but not very deeply, punctured, subseriately so near suture and margin, irregular between; second and fourth interpunctural spaces broader, more regular and higher. Length 9.5 mm.; breadth 7 mm.

Seven (U.S.N.M.) near Fu-lin and west of Fu-lin, altitude 4,000–8,500 feet, July 18 to August 15, 1928, D. C. Graham.

China: Yunnan[1]; Szechuan (Fu-lin); Tibet (Yerkalo[1]). The locality Yerkalo is possibly in Sikang instead of Tibet proper, though Spaeth considers it in the Paleartic region.

Distribution: West China.

Genus **Basiprionota** Chevrolat

Basiprionata CHEVROLAT, 1837, in Dejean, Cat. Col., ed. 3:391.

Prioptera HOPE, 1840, Col. Man., 3:153, 176; BOHEMAN, 1850, Mon. Cassid., 1:44; CHAPUIS, 1875, Gen. Col., 11:368; WAGENER, 1881, Mitt. Münch. Ent. Ver., 5:27; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 310; SPAETH, 1926, Best.-Tab. Eur. Col., 95:7; new synonymy.

Head short and deep, outline circular in anterior view; vertex medially grooved; frons transverse. Antennae often nearly one-half as long as body in male, shorter in female, moderately stout, cylindrical, somewhat flattened distally; basal segments short, distal ones longer with last segment longest. Pronotum strongly transverse, broadly and deeply emarginate anteriorly, exposing most of dorsal surface of head; basal margin prominently trilobed; explanate margins moderately broad at sides. Elytra about as broad as pronotum basally, often considerably broadened posteriorly; explanate margins generally widened near middle; discs subregularly to irregularly punctured, often with some depressions and raised longitudinal lines. Legs moderately stout; tarsi large; claws large and extending beyond lobes of third segment.

The genus contains about 50 species, most of them in the Indo-Chinese and Indo-Malayan subregions. I am indebted to the late Mr. H. S. Barber for calling my attention to the earlier valid name.

Generotype: *Cassida octopunctata* Fabricius (Siam; Java; Borneo).

Range: Oriental region, including Philippine Islands.

KEY TO THE CHINESE SPECIES OF BASIPRIONOTA

1\. Elytral discs either largely black or with two or more small black spots; pronotum either spotted or not, but not distinctly grooved medially........ 2

— Elytral discs immaculate; pronotum not clearly marked, but generally with a distinct median groove........ 4

2.(1) Pronotum with a pair of small black dots or a pitchy area on each side of middle; elytral discs with a large black area or several small black dots 3

— Pronotum immaculate; elytral discs each with a small black spot behind middle near suture; last two antennal segments black........ *B. maculipennis reducta*

3.(2) Pronotum with a pair of small distinct round black spots; elytral discs each with about three small black spots, closely and deeply pnctured; last four antennal segments black........ *B. multipunctata*

— Pronotum with a vague pitchy brown area on each side of center; elytral discs largely black, explanate margins each with a large posterolateral black spot; elytra finely and sparsely punctulate; only last antennal segment black........ *B. whitei*

4.(2) Body not much longer than broad........ 5

— Body one-half again as long as broad; elytral discs fairly even; explanate margins distinctly produced at sutural angles........ *B. angusta*

5.(4) Elytral discs rather uneven, with a conspicuous depression anterior to middle of disc of each........ 6

— Elytral discs not very uneven, with only a shallow depression near middle of disc........ *B. bisignata*

6.(5) Pronotum with lateral margins of disc strongly arcuate; four or five irregular rows of punctures between first and second ridges just behind middle of each elytron; size small: 9–10 mm. in total length........ *B. bimaculata*

— Pronotum with lateral margins of disc not strongly arcuate; seven to nine irregular rows of punctures between first and second ridges just behind middle of each elytron; size large: 11–16 mm. in total length........ *B. chinensis*

Basiprionota angusta (Spaeth), new combination

Prioptera angusta SPAETH, 1914, Suppl. Ent., 3:17[1]; CHUJO, 1934, Sylvia, 5:147[2]. (Type in Berlin Museum.)

Prioptera angusta ab. *fulva* CHUJO, 1934, l.c.[3].

Dorsal surfaces pale ochraceous; explanate margins paler, those of each elytron with a small pitchy spot near posterolateral portion of disc; ventral surfaces pale to dull testaceous; antennae with last two segments black, preceding ones partly pitchy.

Form elongate, more than one-half again as long as broad; fairly convex. Pronotum with disc evenly convex, feebly grooved medially and sparsely punctulate and margins relatively narrow. Elytra long; discs slightly uneven, irregularly punctured; explanate margins narrow, somewhat produced at extreme apices where they are as broad as at middle of sides.

Some (C.A.S.) Kuraru, southern Taiwan, June 10, 1932, and August 10, 1934, Gressitt.

China: Taiwan[1,2,3] (Sozan, Horisha, Kosempo, Koshun, Kankau, Kuraru). April to October.

Distribution: Taiwan.

Basiprionota bimaculata (Thunberg), new combination

(Text figure 1, page 536; pupa)

Cassida bimaculata THUNBERG, 1789, Nov. Ins. Spec., 5:86, pl. 5, fig. 93[1]. (Type in Upsala Museum.)

Cassida bimacula HERBST, 1799, Natursyst. Käfer, 8:262, pl. 132, fig. 4.

Prioptera bimaculata BOHEMAN, 1850, Mon. Cassid., 1:52; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 317[2].

Dorsal surfaces yellowish brown; each elytron with a round black spot on posterolateral portion of explanate margin; distal six antennal segments black or largely black.

Dorsal outline subrounded. Pronotum finely and closely punctate. Elytra as broad basally as pronotum, convex, shiny, finely and closely punctate; punctures partly arranged in longitudinal rows; disc of each slightly raised behind scutellum and with two depressions externally. Length 9–10 mm.; breadth 8 mm.

Several (Lingnan & C.A.S.) Suisapa, Lichuan, July 23—August 22, 1948, Gressitt, on *Premna* and *Liquidambar*.

Hosts: *Premna, Liquidambar formosana* Hance.

China: "China"[1]; Hupeh (Lichuan).

Distribution: South China; Assam[2].

Basiprionota bisignata (Boheman), new combination

(Plate 27, figure 9)

Prioptera bisignata BOHEMAN, 1862, Mon. Cassid., 4:221[1]; WEISE, 1912, Arch. f. Naturg., 78 A 2:96[2]; SPAETH, 1926, Best.-Tab. Eur. Col., 95:8. (Type in Stokholm Museum.)

Prioptera chinensis, GRESSITT *(not* Fabricius), 1939, Pan-Pac. Ent., 15:138[3].

Dorsal surfaces pale ochraceous; explanate margins paler, immaculate, or with a feeble suggestion of a posterolateral spot on each elytron; ventral surfaces black on most of metasternum and parts of abdominal sternites; legs pale with tarsi and femora marked with black; antennae with sixth to ninth segments partly pitchy and last two black.

Pronotum smooth, medially grooved, minutely punctulate, with narrow margins. Elytra fairly long; disc of each with two subsinuate feebly raised lines and two or three depressed areas on basal half; explanate margins not very broad, widest near middle. Length 11.5–13 mm.; breadth 7.5–10 mm.

Six (U.S.N.M.) "China," F. N. Meyer; (Heude) Tien-mu Shan, May, 1937 Piel.

China: North China[1]; Shantung (Tsingtao[2]); Chekiang (Hangchow[3], Tien-mu).

Distribution: Eastern China.

Spaeth (1926, p. 8) refers to *B. pallida* Wagener, 1881, as an aberration of this species, and as occurring only in South China, whereas *B. pallida* is listed as from Malacca in the Coleopterorum Catalogus (Spaeth, 1914, p. 18).

Basiprionota chinensis (Fabricius), new combination

(Plate 27, figure 7)

Cassida chinensis FABRICIUS, 1798, Syst. Ent. Suppl., 84[1]; 1801, Syst. Eleuth., 1:402; HERBST, 1799, Natursyst. Käf., 8:353. (Type in Lund Museum.)

Prioptera satrapa BOHEMAN, 1862, Mon. Cassid., 4:17[2].

Prioptera chinensis, WEISE, 1910, Verh. Naturf. Ver. Brünn, 48:42; WEISE, 1912, Arch. f. Naturg., 78 A 2:96; SPAETH & REITTER, 1926, Best.-Tab. Eur. Col. 95:8[3]; LIU, 1936, Lingnan Sc. Jl., 15:256[4].

Prioptera bimaculata, GRESSITT *(not* Thunberg), 1938, op. cit., 17:575[5].

Large, nearly round in outline. Dorsum testaceous, shiny, each elytron marked with a larger or smaller black spot on explanate margin behind middle; antennae with apical two or three segments black or largely black; occiput pitchy; ventral surfaces entirely testaceous or with metasternum partly black on sides of posterior portions, or on middle; legs testaceous, with undersides of femora and tibiae generally partly blackish. Antennae more than one-half as long as body in male, more than one-third as long in female; prothorax deeply emarginate, minutely punctate, feebly grooved medially, evenly convex at sides; scutellum longer than broad; elytra somewhat uneven, not very heavily punctured except along suture and on depressed areas; explanate margins impunctate; broadest before middle in male and at middle in female. Length 11–16 mm.; breadth 9.5–14 mm.

Ten (A.M.N.H.) Yen-ping, May, 1916, April, June and July, 1917, H. Caldwell; (Heude) Tien-mu Shan, May, Ihing, July; (M.C.Z.) Kiukiang, June, 1887, A. E. Pratt; Chungking, Szechuan, June, 1932, G. Liu; (Lingnan) Behludin, August 21, 1940, Gressitt; (U.S.N.M.) Yachow, 2,000 feet, July, 1928, Muping, August 25, 1929, Wen Chuan Shien, 11,500 feet, 30 miles NNW. of Kuanshien, 1933, Wentang, 11,000 feet, 14 miles S. of Chungking, June 28, 1933, and Suifu, May 1, 1929, D. C. Graham; (Lingnan) Chang-ting, June, 1940, Maa. Four (U.S.N.M.) Chin-ling Mountains, Shensi, April-May, 1904, by Eliot Blackwelder are questionably referred to this species.

China: Sikang (Yachow, Muping); Szechuan (Wasse-Kou[3], Chungking, Wen Chuan Shien, Wentang, Suifu, Behludin); Kiangsi (Kiukiang); Kiangsu[2,4] (Shanghai, Ihing); Chekiang (Tien-mu); Fukien (Yen-ping, Chang-ting); Kwangtung[5] (Lin-chow). May to August.

Distribution: South China[1].

Basiprionota maculipennis reducta (Gressitt), new combination

(Plate 27, figure 6)

Prioptera maculipennis subsp. *reducta* Gressitt, 1938, Lingnan Sc. Jl., 17:185[1], 575[2]. (Type in U.S.N.M.)

Dorsal surfaces yellowish ochraceous to dirty testaceous, transparent to opaque on discs, fairly transparent on explanate margins; disc of each elytron with a small squarish spot, sometimes vague, at top of posterior declivity near suture, and explanate margin of each with a large squarish spot on posterolateral portion; ventral surfaces black on part of metasternum; antennae dusky to black on last two or more segments.

Pronotum evenly convex, ungrooved and impunctate on disc, not very broad on explanate margins. Elytra with suture raised behind scutellum, discs each with two irregular depressed areas near middle and subregularly punctured; explanate margins suddenly broadened behind humeri in male, gradually broadened to behind middle in female, much narrower apically. Length 9.5–11 mm.; breadth 7.5–8.5 mm.

China: Hainan[1,2] (Ta-hian, Ta-hau, Faan-no, Nai-suen, Tai-pin, Cheung-kon). June to September.

Distribution: Hainan Island.

Basiprionota multipunctata (Gressitt), new combination

Prioptera multipunctata GRESSITT, 1938, Lingnan Sc. Jl., 17:186[1], 575. (Type in C.A.S.)

Dorsal surfaces dull ochraceous, paler, subtransparent and reticulate on explanate margins; pronotum marked with a pair of widely spaced round black dots on disc; elytra with three small black spots on disc of each: (1) largest, oval, near scutellum, (2) narrow, oblique, behind humeral callus, (3) smallest, rounded-oval, on third interpunctural strip behind middle; explanate margin of each elytron with a small, narrow black spot on posterolateral portion; antennae with distal half pitchy, becoming black near apices; ventral surfaces with metasternum partly black.

Pronotum smooth, evenly convex, impunctate and ungrooved on disc, slightly depressed anterior to median posterior lobe; explanate margins of equal width along sides. Elytra with discs very closely, and in part irregularly, punctured, each with two feebly depressed areas near middle and none of interpunctural strips distinctly raised; explanate margins gradually widened behind humeri, broadest near middle, narrow distally, and slightly thickened along borders. Length 7.4 mm.; breadth 5.4 mm.

China: Hainan (Ta-hau[1]); July.

Distribution: Hainan Island.

Basiprionota whitei (Boheman), new combination

(Plate 27, figure 4)

Prioptera Whitei BOHEMAN, 1856, Cat. Col. Ins. Brit. Mus., 9:11[1]; 1862, Mon. Cassid., 4:26; SPAETH & REITTER, 1926, Best.-Tab. Eur. Col., 95:8; LIU, 1936, Lingnan Sc. Jl., 15:25[2]. (Type in British Museum.)

Prioptera trabeata FAIRMAIRE, 1888, Ann. Soc. Ent. France, 32:46[3].

Prioptera whitei trabeata, SPAETH, 1914, Col. Cat., 62:19; GRESSITT, 1938, Lingnan Sc. Jl., 17:383[4], 577[5]; 1938, Pan-Pac. Ent., 15:139[6].

Dorsal surfaces ochraceous with disc of each elytron black except for borders, explanate margins of each elytron with a broad black spot on posterolateral portion and pronotal disc with or without a dusky to blackish spot on each side of middle; antennae with two distal segments black; ventral surfaces with metasternum largely black.

Pronotum with disc smooth, feebly grooved medially and depressed opposite scutellum. Elytra minutely and irregularly punctured except along borders and in each of two depressed areas near middle of each; explanate margins fairly broad, evenly widened behind humeri, hardly less than one-half as broad at apices as at middle of sides. Length 10–11.5 mm.; breadth 8–9.2 mm.

Several (C.A.S.) Hangchow, May 25, 1932, E. C. Van Dyke; (A.M.N.H.) San-chiang, Foochow, and "Foochow region to Kuatun region" (Min River), 1927, C. H. Pope; (U.S.N.M.) Kiukiang, June, 1887, Pratt; Mokan Shan, N. Gist Gee; Kuling, May 30, 1936, C. Y. Wong; (Lingnan) Shaowu, Chungan, Kien-yang, Chang-ting, Tai-yu, April-August, Maa.

China: Kiangsu[2]; Chekiang[6] (Mokan Shan, Cha-yuan, Hangchow); Kiangsi[3] (Wong-sa-shue, Hong Shan[4], Kiukiang, Kuling, Tai-yu); Central China[1]; Fukien (Liung-chon San, Gang-keu[4], San-chiang, Min River, Shaowu, Chungan, Kien-yang, Chang-ting); Hunan[5] (Lam-mo); Kwangtung[5] (Lien Distr., Yao Shan, Yim-na Shan, Tsin-leong Shan). May and September (Chekiang); May to July (South China).

Distribution: Eastern and South China.

Tribe **ASPIDOMORPHINI**

Aspidomorphini of authors.

Tarsal claws with a comblike set of teeth on one or both sides of each claw. Pronotum not emarginate anteriorly. Posternum not grooved for reception of antennae.

Genus **Aspidomorpha** Hope

Aspidomorpha HOPE, 1840, Col. Man., 3:158; BOHEMAN, 1854, Mon. Cassid., 2:242; CHAPUIS, 1875, Gen. Col., 11:401; WEISE, 1897, Deutsche Ent. Zeits., 1897:105; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 324.

Head subrounded in anterior outline, strongly oblique in lateral outline; fronto-clypeus smooth, evenly raised to apex below antennal insertions. Antennae barely reaching to lateral angles of prothorax; basal segments very slender, subcylindrical; distal four or five segments thicker, somewhat flattened. Prothorax transversely elliptical, much narrower than elytra; lateral angles broadly rounded; explanate margins smooth, as large in area as disc, or larger. Elytra generally with a conical tubercle at suture a short distance behind scutellum; discs smooth or irregular, finely seriate-punctate; explanate margins very broad, occupying about as much area as discs, feebly declivitous. Prosternum fairly narrow between anterior coxal cavities, more than three times as wide, and broadly rounded, posteriorly. Tarsi fairly narrow; claws extending slightly beyond apex of third segment, each claw with a several-toothed comb on each side.

Generotype: *Cassida miliaris* Fabricius (Oriental region).

Range: Ethiopian and Oriental regions; North China; Siberia; Japan.

As far as the Oriental species seen by the writer are concerned, *A. miliaris* Fabricius, the generotype, falls in a group apart from the remainder of the species in the genus, since the larva is quite different from the known larvae of other species and the adult lacks the dorsal tubercle of the elytra and is excessively broad, sometimes being broader than long.

KEY TO THE CHINESE SPECIES OF ASPIDOMORPHA

1. Elytral discs evenly convex and smooth, lacking a postbasal tubercle...... 2

— Elytral discs with a common, subacute tubercle at suture a short distance behind scutellum 3

2.(1) Length of body 10–13.5 mm.; elytra marked with black spots or patches........ *A. miliaris*

— Length of body 6–7 mm.; elytral discs and marginal patches red-brown........ *A. transparipennis*

3.(1) At least anterior angles of explanate margins of elytra with pigmented patches extending to lateral borders........ 4

— Neither anterior nor posterior lateral angles of explanate margins of elytra with dark patches reaching to lateral borders; body rounded; last two antennal segments black........ *A. fuscopunctata*

4.(3) Size large; at least 10 mm. in body length........ 5

— Size small; under 8.5 mm. in length of body........ 6

5.(4) Form rounded; posterolateral angles of explanate margins of elytra with at least partial pigmented patches; elytral discs irregular........ *A. sanctae-crucis*

— Form subtriangular, broadest near anterior angles of explanate margins; posterolateral angles of explanate margins with pigmented area; elytral discs fairly even behind middle........ *A. dorsata*

6.(4) Only anterior angles of explanate elytral margins with dark spots........ 7

— Both anterior and posterior angles of explanate elytral margins with dark areas 8

7.(6) Explanate margins of elytra deeply pigmented along suture at apex; last two antennal segments black........ *A. chandrika*

— Explanate margins of elytra not pigmented along suture at apex; last two antennal segments only slightly pigmented........ *A. furcata*

8.(6) Elytra finely punctate-striate without depressions; elytral discs yellowish-brown; body outline ovate........ *A. difformis*

— Elytra with nine rows of strong punctures and one or two depressions; elytral discs dark brown; body outline nearly round........ *A. indica*

Aspidomorpha chandrika Maulik

Aspidomorpha chandrika MAULIK, 1918, Ann. Mag. N. H., (9) 1:322[1]; 1919, Fauna Brit. Ind., Hisp. & Cass.: 331, fig. 102[2]; GRESSITT, 1938, Lingnan Sc. Jl., 17:577[3]. (Type in Indian Museum.)

Golden in life; or with elytral discs dark reddish brown. Dried specimens whitish testaceous to dark reddish brown; pronotum pale testaceous, more yellowish on disc; elytra with discs reddish testaceous to dark reddish brown; pale on parts of base, including anterior side of tubercle; explanate margins pale testaceous with bases reddish brown.

Dorsal outline rounded-oval. Pronotum nearly twice as broad as long, evenly arcuate anteriorly, rounded-angulate at sides. Elytra with humeri subangulate and slightly projecting, dorsal tubercle subacute and punctures almost lacking on inner half of posterior two-thirds: Length 7–7.5 mm.; breadth 5.8–6.5 mm.

Host: *Ipomoea* sp.

China: Hainan Island (Tai-pin-ts'uen, Sam-ts'uen-kai-hui[3]).

Distribution: India[1]; Burma[2]; Hainan Island.

Aspidomorpha difformis (Motschulsky)

Deloyala difformis Motschulsky, 1860, Etud. Ent., 9:27[1]. (Type in Moscow Museum?.)

Aspidomorpha difformis, Boheman, 1862, Mon. Cassid., 4:277, Baly, 1874, Trans. Ent. Soc. London, 1874:211[2]; Kraatz, 1879, Berl. Ent. Zeits., 23:270; Gorham, 1885, Proc. Zool. Soc. London, 1885:280[3]; Weise, 1900, Arch. Naturg., 66:295; Matsumura, 1907, Thous. Ins. Japan, 4:39, pl. 58, fig. 34; Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.):(129)[4]; 1926, Best.-Tab. Eur. Col., 95:10; Doi, 1926, Dobutsug. Zasshi, 39:337; Yokoyama, 1930 (Col. of Japan), 1:20, pl. 2, fig. 6; Yuasa, 1932, Nippon Konchu Zukan: 587[5], fig. 1147; Chujo, 1934, Sylvia, 5:152; Gressitt, 1939, Pan-Pac. Ent., 15:139[6].

Aspidomorpha difformis ab. *japonica* Spaeth, 1926, Best.-Tab. Eur. Col., 95:10[7]; Yuasa, 1932, Nippon Konchu Zukan: 587; Chujo, 1934; Sylvia, 5:153; Spaeth, 1942, Arb. morphol. taxon. Ent. Berlin-Dahlem 9:12 (Erzendjanzsy, Manchuria).

Pronotal disc yellow; elytral discs dull testaceous, feebly marked with reddish to completely dark pitchy brown; explanate margins hyaline, fairly transparent, a distinct black patch on humerus and another on posterolateral portion of each elytron; ventral surfaces brownish testaceous; legs pale; antennae pale except for distal segment.

Rounded-oval in outline; feebly convex; elytra bluntly tuberculate behind scutellum. Prothorax transversely elliptical, rounded at sides. Elytra distinctly broader than prothorax; humeri rounded, slightly projecting; discs finely seriate-punctate, the punctures arranged at somewhat irregular intervals in many of the rows. Length 8–9.5 mm.; breadth 6.4–7 mm.

Some (Lingnan) Shaowu and San-kang, May 8 to June 9, 1943, Maa; (C.A.S.) Rikuchiu, July, 1916, J. C. Thompson, Tokyo, 1931, Gressitt, Kyoto, July, 1923, E. C. Van Dyke, Japan.

Hosts: *Calystegia sepium* var. *japonica* Makino; *Chenopodium* sp.

China: Manchuria[2] (Chin San, Weisohn[6]); Chekiang[6] (Hangchow, Mokan Shan); Fukien (Shaowu, Sankang). May to August (Japan); August-September (Manchuria); May, June and September (southeastern China).

Distribution: Hokkaido[3]; Honshu[3,7]; Kyushu[3]; Ryukyu Islands[5] (Okinawa); Korea[4]; eastern China; eastern Siberia[2] (Ussuri[7]; Amur[1]).

Aspidomorpha dorsata (Fabricius)

(Plate 27, figure 3)

Cassida dorsata FABRICIUS, 1787, Mant. Ins., 1:641[1]; 1792, Ent. Syst., 1:301; 1801, Syst. Eleuth., 1:401; LINNAEUS, 1787, Syst. Nat., ed. 13, Gmelin 1, 4:1641; HERBST, 1799, Natursyst. Käf., 8:342. (Type in British Museum.)

Aspidomorpha dorsata, BOHEMAN, 1854, Mon. Cassid., 2:296; SPAETH, 1914, Col. Cat., 62:68[2]; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 332[3]; GRESSITT, 1938, Lingnan Sc. Jl., 17:188[4], 578[5].

Aspidomorpha calligera BOHEMAN, 1854, Mon. Cassid., 2:297[6]; WEISE, 1897, Deutsche Ent. Zeits., 1897:104[7] (= *dorsata).*

Dorsal surfaces with explanate margins hyaline, shiny and fairly transparent except for humeri which are reddish brown; pronotal disc testaceous brown, generally transparent; elytral discs testaceous brown to dark reddish brown, darker areas mostly at sides and along suture, often as spots; ventral surfaces testaceous; antennae with last two segments black.

Dorsal outline rounded-triangular. Pronotum twice as broad as long, elliptical; lateral angles rounded, placed slightly behind middle. Elytra one-half again as broad as pronotum; humeri prominent and rounded; explanate margins very wide, broader anteriorly than discs; discs finely seriate-punctate; dorsal tubercle acute. Length 10–13 mm.; breadth 8.7–12 mm.

Host: *Ipomoea* sp.

China: Hainan[4,5] (Ta-hian, Nodoa, Tai-pin, Nan-fung, Kachek, Cheungkon). April to July.

Distribution: India[3,6,7]; Ceylon[3]; Assam[3]; Burma[3]; Hainan Island; Siam[1]; Malaya[2]; Sunda Island[2]; Celebes[3].

Aspidomorpha furcata (Thunberg)

(Plates 31 and 32; plate 36, figures 1, 4, and 7)

Cassida furcata THUNBERG, 1789, Nov. Ins. Spec., 5:87, pl. 5, fig. 96[1]; HERBST, 1799, Natursyst. Käf., 8:265, pl. 132, fig. 7. (Type in Copenhagen University Museum.)

Cassida dorsata OLIVIER *(not* Fabricius), 1790, Enc. Meth., 5:386; 1808, Ent., 6:961; 97, pl. 3, fig. 45.

Cassida micans FABRICIUS, 1801, Syst. Eleuth., 1:398[2].

Aspidomorpha micans BOHEMAN, 1854, Mon. Cassid., 2:313; WIESE, 1901, Deutsche Ent. Zeits., 1901:52.

Aspidomorpha furcata, WEISE, 1897, op. cit., 1897:104[3]; SPAETH, 1913, Ann. Mus. Nat. Hung., 11:46[4]; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 333[5]; MIWA, CHUJO & MITONO, 1932, Trans. Nat. Hist. Soc. Formosa, 22:304[6]; CHUJO, 1934, Sylvia, 5:151; LIU, 1936, Lingnan Sc. Jl., 15:257[7]; GRESSITT, 1938, op. cit., 17:189[8], 384[9], 578[10]; 1939, Pan-Pac. Ent., 15:139[11].

BIOLOGY: KERSHAW & MUIR, 1907, Trans. Ent. Soc. London, 1907:250; HUTSON, *et al.*, 1929. (See section on bionomics.)

Brilliant golden in life; sometimes with discs dark purplish brown. Dried specimens with dorsal surfaces pale testaceous to reddish brown; pronotum testaceous with explanate margins transparent; elytra with discs testaceous, generally with most of punctures, sides, dorsal tubercle and one or two oblique lines on posterior portion reddish; explanate margins of elytra with bases narrowly reddish brown, remainder very pale and transparent, sometimes slightly pigmented near borders.

Dorsal outline subrounded, slightly longer than broad. Pronotum transversely elliptical, twice as broad as long, with narrow lateral angles placed slightly behind middle. Elytra with humeri rounded and feebly projecting; discs with dorsal tubercle subobtuse and blunt and punctures sparse on inner half. Length 6.6–8.8 mm.; breadth 5.5–7.2 mm.

Some (M.C.Z.) Kiangsu; Kweiping & Pingloo, Gaines Liu; (A.M.N.H.) Yen-ping, Spring, 1915, May, 1916 and June 17, 1917, Harry Caldwell; (U. Nanking) Chengtu; (C.A.S.) Formosa: Hori, June 7, Rokki, May 17, Kuraru, August 9, 1934, Gressitt; (Lingnan) Si-tsin-chi, Lung-chi, August 30, 1940, Maa; Luichow Peninsula, August, 1950.

Hosts: *Ipomoea Batatas* Lamk.; *I. aquatica* Forsk.; *I. cairica* Sweet; *I. digitata Linn.; ? Colocasia antiquorum* var. *esculenta* Schott (Aroideae).

China: Kiangsu; Fukien (Yen-ping, Amoy[7], Shanghang[9], Lung-chi); Kwangtung[9,10] (Tsin-leong Shan, Tai-yong, Canton, Ts'in-pei, San-po-hui, Yam-na Shan, Yao Shan, Sheung-shui-heung, Luichow); Hong Kong[11]; Kwangsi (Kweiping, Pingloo); Hainan Island[8,10] (Fan-ta, Ta-hian, Ta-hau, Cheung-kon, Liamui, Hoihow, Kachek, Nam-ting-ts'uen, Kom-yan, Lokkei, Nodoa, Dome Mountain, Nam-fung, Tai-pin, Tai-tsing-lam-ts'uen, Nam-liu-ting); Szechuan (Chengtu); Taiwan[4] (many localities); Botel-Tobago Island[6]. All the year round at Canton.

Distribution: India[3]; Ceylon[5]; Assam[5]; Burma[5]; South China; Hainan; Formosa; Indo-China[11]; Thailand[1] Malaya; Sunda Island[2].

Aspidomorpha fuscopunctata Boheman

Aspidomorpha fuscopunctata Boheman, 1854, Mon. Cassid., 2:298[1]; Weise, 1857, Deutsche Ent. Zeits., 1897:104[2]; Spaeth, 1912, Sarawak Mus. Jl., 1:117[3]; 1914, Col. Cat., 62:68[4]; Maulik, 1919, Fauna Brit. Ind., Hisp. Cass.: 326[5]; Gressitt, 1938, Lingnan Sc. Jl., 17:189[6], 579[7]; 1939, Pan-Pac. Ent., 15:140[8] (Type in Stockholm Museum.)

Aspidomorpha rubrodorsata Boheman, 1854, Mon. Cassid., 2:310[9].

Iridescent greenish golden in life. Dried specimens with dorsal surfaces yellowish testaceous; pronotal and elytral discs subtransparent, latter with punctures appearing reddish brown in certain lights; explanate margins quite transparent, very pale, sometimes darker near borders.

Nearly circular in dorsal outline. Pronotum transversely elliptical, subangulate posterolaterally, not quite twice as broad as long. Elytra nearly twice as broad as pronotum; humeri rounded, slightly projecting beyond lateral angles of pronotum; discs with a common tubercle behind scutellum forming a right angle in lateral outline, seriate-punctate with irregularly spaced punctures. Length 9–9.4 mm.; breadth 8.2–8.5 mm.

China: Kwangtung[7] (Yao Shan); Hainan[6,8] (Ta-hian, Five Finger Mountains, Liamui, Nodoa).

Distribution: India[2]; Burma[2]; Indo-China[7]; South China[4]; Hainan; Malaya[5]; Sunda Islands[1,3,9]; Philippines[7].

Aspidomorpha indica Boheman

Aspidomorpha indica Boheman, 1854, Mon. Cassid., 2:318[1]; Weise, 1905, Deutsche Ent. Zeits., 1905:123; Spaeth, 1913, Ann. Mus. Nat. Hung., 11:46[2]; 1914, Col. Cat., 62:68[3]; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 327; Chujo, 1934, Sylvia, 5:153; Gressitt, 1939, Pan-Pac. Ent., 15:140[4]. (Type in British Museum.)

Golden in life; dried specimens with pronotum and elytral margins pale hyaline yellow, transparent, latter with two dark-brown spots on each side: at humerus and on posterolateral area; elytral discs pale testaceous to dark reddish brown, often faintly marked with reddish on pale background; ventral surfaces pale; antennae with apical two or three segments black.

Subcircular in outline, very slightly longer than broad. Prothorax transversely elliptical, twice as broad as long, broadly rounded laterally. Elytra slightly broader than prothorax; humeri rounded, slightly projecting; explanate margins broad; discs tuberculate behind scutellum, finely seriate-punctate. Length 6.4–7.8 mm.; breadth 5.8–6.7 mm.

One (Lingnan) Nan-yo-miao, 1,000 meters, on bindweed, May, 1940, Richardson.

Host: *Ipomoea* sp.; *Convolvulus japonicus* Thunberg (?)

China: Yunnan[3]; Szechuan (Nan-yo-miao); Taiwan (Arisan, Kosempo[2]).

Distribution: India[1]; West China; Indio-China[4]; Taiwan.

This form, as suggested by Maulik (1919, p. 328), is probably at best a subspecies of *A. amabilis* Boheman. The writer is inclined to the view that these two, together with *A. chandrika* Maulik, may eventually prove to be subspecies, or color forms, of *A. furcata* (Thunberg), in spite of the ease with which most of them may be keyed.

Aspidomorpha miliaris (Fabricius)

(Plate 28, figure 1; plate 36, figure 2)

Cassida miliaris Fabricius, 1775, Syst. Ent.: 91[1]; 1781, Spec. Ins., 1:111; 1787, Mant. Ins., 1:64; 1792, Ent. Syst., 1:300; 1801, Syst. Eleuth., 1:400 ("St. Helena"); Olivier, 1790, Enc. Meth., 5:385; 1808, Ent., 6:943; 97, pl. 2, fig. 25[2]; Herbst, 1799, Natursyst. Käf., 8:312, pl. 135, fig. 8*. (Type in British Museum.)

Cassida quatuordecimpunctata Olivier, 1808, Ent., 6:943; 97, pl. 4, fig. 66.

Aspidomorpha celebensis Blanchard, 1853, Voy. Pole Sud (d'Urville), 4:316, pl. 18, fig. 9[3]; Boheman, 1862, Mon. Cassid., 4:281.

Aspidomorpha miliaris, Boheman, 1854, Mon. Cassid., 2:261; Wollaston, 1877, Col. St. Helenae: 215 (St. Helena ?); Weise, 1896, Deutsche Ent. Zeits., 1896:16; Spaeth, 1903, Ann. Mus. Nat. Hung., 1:138; 1914, Col. Cat., 62:69; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 334, figs. 103–4[4]; Gressitt, 1938, Lingnan Sc. Jl., 17:189[5], 579[6]; 1939, Pan-Pac. Ent., 15:140[7].

Aspidomorpha amplissima Boheman, 1854, Mon. Cassid., 2:260[8]; Weise, 1896, Deutsche Ent. Zeits., 1896:16.

Aspidomorpha miliaris abb. *flaveola & inundata* Weise, 1910, Philip. Jl. Sc., D, 5:143[9].

Biology: Schultze, 1908, Philip. Jl. Sc., A, 3:264, pl. 2, pl. 3, figs. 1–4, pl. 6, figs. 6–9[10]; Bishop, 1909, Jl. Sts. Br. Roy. Asiat. Soc., 53:129.

Pale straw-yellow to ochraceous, rarely to pitchy-black; pronotum immaculate; elytra with extreme basal border and apex of suture black; each marked on explanate margins with a large oblique spot behind humerus and another in posterolateral portion, and on disc with one to ten spots of varying sizes, sometimes confluent, of black; ventral surfaces with only sides of metasternum black to entirely black; antennae with last three segments black to entirely pitchy black.

Very broad, nearly circular in outline, feebly convex. Prothorax about twice as broad as long, broadly rounded at sides, smooth; elytra nearly twice as broad as prothorax, rounded at humeri, broadest at end of basal third, where explanate margins are as broad as discs. Length 9.5–15 mm.; breadth 8.5–13.3 mm.

One (C.A.S.) Hong Kong, 1909, Dr. J. C. Thompson.

Hosts: *Calonyction bona-nox* Boyar, *Convolvulus* sp., *Ipomoea triloba* Linn., *I. pes-caprae* Linn., *I. Batatas* Lamk., *Gmelina arborea* (?).

China: Yunnan[3]; Hong Kong; Hainan Island[5,6] (Ta-hian, Tai-pin, Liamui, Hoihow, Nam-liu-tin, Kachek, Mau-ying-ts'uen, Nam-fung, Nodoa, Lin-fa Shan, Lok-kei, Yau-ma-woh). April to August (Hainan).

Distribution: India[2]; Andaman Islands[4]; Assam[5]; Burma[4]; Yunnan; Hainan Island; Indo-China[6]; Malaya; Sumatra[7]; Java[1]; Borneo; Celebes[3]; New Guinea; Philippine Islands[8,9,10].

Aspidomorpha sanctae-crucis (Fabricius)

(Plate 28, figure 3; plate 36, figure 3)

Cassida St. Crucis Fabricius, 1792, Ent. Syst., 4 (App.): 446[1]; 1801, Syst. Eleuth., 1:401; Illiger, 1808, Mag. Ins., 5:227*. (Type in Copenhagen University Museum.)

Cassida elevata Fabricius, 1801, Syst. Eleuth., 1:399[2].

Aspidomorpha sanctae-crucis, Boheman, 1854, Mon. Cassid., 2:287, pl. 6, fig. B; Spaeth, 1914, Col. Cat., 62:69[3].

Aspidomorpha Heroina Boheman, 1854, Mon. Cassid., 2:284 (no loc.).

Aspidomorpha limbipennis Boheman, 1854, l.c.: 285; 1862, 4:266[4].

Aspidomorpha bajula Boheman, 1854, op. cit., 2:288 ("America").

Aspidomorpha lobata Boheman, 1854, l.c.: 289[5]; Spaeth, 1914, Deutsche Ent. Zeits., 1914:544* (Subsp. ?).

Aspidomorpha Stevensi Baly, 1863, Jl. Ent., 1:11[6] (Subsp. ?).

Aspidormorpha fraterna Baly, 1863, l.c.[7] (Subsp. ?).

Aspidomorpha Stae Crucis, Baly, 1863, l.c.: 13[8].

Aspidomorpha orientalis (Dejean ms.) Gemminger & Harold, 1872, Cat. Col., 12:3650[9].

Aspidomorpha St. crucis, Weise, 1897, Deutsche Ent. Zeits., 1897:102[10].

Aspidomorpha insularis Spaeth, 1912, Sarawak Mus. Jl., 1:118[11].

Aspidomorpha sanctae-crucis, Maulik, 1913, Rec. Ind. Mus., 1913:111; Fauna Brit. Ind., Hisp. & Cass.: 329[12], fig. 101; Gressitt, 1938, Lingnan Sc. Jl., 17:189[13], 580[14]; 1939, Pan-Pac. Ent., 15:140[15].

Biology: Weise, 1897, Deutsche Ent. Zeits., 1897:102; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 273, figs. 85–7.

Pronotal and elytral discs and two or four splotches on elytral explanate margins brilliant golden in life, testaceous to pitchy in dried specimens; explanate margins semitransparent and amber colored except inner lateral portions of elytral margins which are generally more transparent, or else brown to pitchy; ventral surfaces pale to pitchy; anntennae with last two segments black.

Nearly circular in outline; moderately convex with elytra raised to a pointed tubercle just behind scutellum. Prothorax nearly twice as broad as long, rounded laterally, smooth. Elytra nearly twice as broad as prothorax, rounded at humeri; discs conjointly tuberculate, rugulose and subseriate-punctate. Length 9.6–16 mm.; breadth 9.6–15 mm.

Some (A.M.N.H. and U.NK) Omei Shan, August 13, 1938, Yen-ping, Spring, 1915, and July, 1920, on roses; (Lingnan) Luichow Peninsula, August, 1950.

Hosts: *Ipomoea* sp., *Tectona* sp., *Michelia* sp. (?)

China: Yunnan (Tengyuen—Tali-Fu[12]); Hainan Island[13,14] (Nodoa, Ta-hian, Ta-han, Ta-hau, Dome Mountain, Vo-lau, Fan-ta, Cheung-kon, Liamui, Tai-pin, Tai-tsing-lam-ts'uen, Lok-kei, Nam-fung, Ch'ung-mei, Nai-suen, Kom-yan, Five Finger Mountains); Kwangtung (Lien, Yang-shan[14], Luichow Peninsula); Fukien (Yen-ping); Szechuan (Omei Shan). March to November (Hainan).

Distribution: India[5]; Ceylon[4]; Assam[12]; Burma[10]; South China; Hainan; Indo - China[6,7,8]; Thailand[8,11]; Malaya, Sunda Islands[1,2,3,9,11,15].

Aspidomorpha transparipennis (Motschulsky)

Coptocycla transparipennis MOTSCHULSKY, 1860, Etud. Ent., 9:41[1]. (Type in Moscow Museum ?.)

Aspidomorpha transparipennis, KRAATZ, 1879, Deutsche Ent. Zeits., 23:142; WEISE, 1900, Arch. f. Naturg., 66 (1):295[2]; SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64:(129[3]); MATSUMURA, 1931, Nippon Konchu Daizukan: 226, fig. 620[4]; CHUJO, 1934, Sylvia, 5:151; SPAETH, 1942, Arb. morphol. taxon. Ent. Berlin-Dahlem, 9:12 (Erzendjanzsy).

Aspidomorpha elliptica GORHAM, 1885, Proc. Zool. Soc. London, 1885, 280[5].

Aspidomorpha transparipennis ab. *elliptica* CHUJO, 1934, Sylvia, 5:151.

Aspidomorpha transparipennis var. *vetula* WEISE, 1900, Arch. f. Naturg., 66, 1:295[6].

Pronotal disc pale testaceous to amber; explanate margins pale hyaline, transparent, those of elytra with a dark reddish brown patch at humerus and another on posterolateral portion; elytral discs transparent pale testaceous to dark pitchy red-brown with a small pale spot behind scutellum; ventral surfaces and legs pale with last two or three segments slightly darkened.

Dorsal outline oblong-oval; feebly convex; elytra hardly raised at suture behind scutellum. Pronotum subsemicircular, slightly convex basally; disc smooth. Elytra slightly broader than prothorax; humeri briefly rounded, hardly projecting; discs very finely seriate-punctate. Length 6.3–7 mm.; breadth 4.7–5 mm.

Host: *Chenopodium* (?).

China: Manchuria (Erzendjanzsy).

Distribution: Japan (Hokkaido[4]; Honshu [2,5,6]); Korea[3]; Amur[1]; North China.

Genus **Sindia** Weise

Sindia WEISE, 1897, Deutsche Ent. Zeits., 1897:105; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 340.

Head with outline circular in anterior view, swollen and subtuberculate just inferior to antennal insertions; eyes large, elliptical. Antennae barely reaching to humeral angles; basal six segments subcylindrical, slightly thickened distally, glabrous, distal segments thicker, more cylindrical, hairy. Prothorax much broader than long; explanate margins completely covering head, nearly one-fourth as broad as pronotal disc. Elytra slightly broader than prothorax, subparallel-sided; explanate margins about one-fourth as wide as a single elytral disc. Prosternum flat, broadly rounded posteriorly. Tarsi moderately broad; claws projecting beyond third segment, bearing combs on inner faces.

Generotype: *Cassida clathrata* Fabricius (India).

Range: India; China.

Sindia sedecimmaculata (Boheman)

Cassida sedecimmaculata Boheman, 1856, Cat. Col. Ins. Brit. Mus., 9:119[1]; 1862, Mon. Cassid., 4:290. (Type in Stockholm Museum.)

Aspidomorpha sedecimmaculata, Gemminger & Harold, 1874, Cat. Col., 12:3651.

Sindia sedecimmaculata, Spaeth, 1901, Verh. Zool.-Bot. Ges. Wien, 51:347[2]; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 343[3]; Chen, 1935, Sinensia, 6:780, fig. 7[4].

Orange-brown with black spots in life. Dried specimens with dorsal surfaces pale ochraceous: pronotum with a large black spot on each side of disc; elytra with a common transverse oval spot behind scutellum, and six other subrounded black spots on each; including sutural spot, arranged in three oblique rows on each elytron, three spots in second row and first spot each of second and third rows touching border of explanate margin; latter not very transparent; antennae, legs and ventral surfaces ochraceous with central portions of metasternum and abdominal segments black.

Body oblong-oval in dorsal outline, moderately convex, highest behind middle. Pronotum nearly twice as broad as long, feebly punctured on disc. Elytra with humeri rounded, not very prominent, discs in large part subseriately punctured and explanate margins somewhat declivitous. Length 7 mm., breadth 5 mm.

China: Kweichow[4].

Distribution: Eastern India[1,2] (Sikkim[3]); Southwestern China.

Genus **Sindiola** Spaeth

Sindiola Spaeth, 1903, Ent. Tidskr., 1:112; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 344; Spaeth, 1932, Rev. Zool. Bot. Afr., 22:227; 1938, Ent. Tidskr., 59:231.

Head subrounded, oblique; frontoclypeus raised above, emarginate below. Antennae reaching humeri, hardly thickened distally; third segment long. Prothorax transversely elliptical, bluntly rounded at each side. Elytra sculptured, reticulate, raised on suture behind scutellum, slightly narrowed posteriorly to parallel-sided. Prosternum broad and rounded posteriorly. Tarsi broad; claws with long distinct oblique teeth on each side (comblike structure).

Maulik gives the parallel-sided body form, and the humeral angles of the elytra, as important characters of the genus, besides the claw character, but the following species and others more recently included by Spaeth are much more like *Laccoptera* in these two former characters.

Generotype: *Aspidomorpha (Sindiola) parallelipennis* Spaeth.

Range: Southeastern Asia.

Sindiola hospita (Boheman)

(Plate 27, figure 5)

Laccoptena hospita BOHEMAN, 1855, Mon. Cassid., 3:681. (Type in Stockholm Museum ?.)

Laccoptera vigintisexnotata subsp. *puncticolle* GRESSITT, 1938, Lingnan Sc. Jl., 17:1892, 5823; new synonym. (Type in U.S.N.M.)

Sindiola hospita, SPAETH, 1938, Ent. Tidskr., 59:2324.

Dorsal surfaces testaceous transparent, marked with black; pronotum with six rounded spots forming a transverse ellipse on disc, two posterior spots largest; elytra with a common spot on tubercle and each with an oblique broken band behind humerus, a large posterolateral spot partly on disc and partly on explanate margin, and several small spots, mostly on base and parallel to suture; ventral surfaces testaceous.

Dorsal outline rounded-triangular, subpentagonal; body rather strongly convex. Pronotum one-half again as broad as long, elliptical, broadly rounded laterally; disc slightly uneven, feebly punctured. Elytra distinctly tuberculate behind scutellum, deeply seriate-punctate, alternate interspaces more strongly raised; explanate margins grossly punctured. Length 8.7–9.2 mm.; breadth 6.6–7.3 mm.

Several (M.C.Z.) Kwei-shien and Kwei-ping, April, 1933, and Yung-shien, 1933, Gaines Liu.

China: Hainan (Ta-han, Ta-han[2], Lung-hou, Kachek, Lok-kei, Nam-fung, Hau-ying[3], Nodoa); Kwangsi (Yung-shein, Kwei-shien, Kwei-ping); Szechuan[4]. April to August.

Distribution: Hainan Island; South China; Indo-China[1] (Annam[4]).

Genus **Laccoptera** Boheman

Laccoptera BOHEMAN, 1855, Mon. Cassid., 3:55; CHAPUIS, 1875, Gen. Col., 11:408; WEISE, 1897, Deutsche Ent. Zeits., 1897:205; 1899, Arch. f. Naturg., 65, 1:246; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 346.

Head rounded-oval in anterior outline, strongly oblique in transverse outline, nearly horizontal below; frontoclypeus raised, campanuliform. Antennae extending beyond humeri, slightly thickened distally; segments subcylindrical, third longer than scape. Prothorax transverse, covering head, not grooved at sides for reception of antennae. Elytra rough, broader than prothorax, conjointly subtriangular or trapezoidal in dorsal outline, raised on suture behind scutellum; explanate margins fairly broad anteriorly, moderately declivitous. Prosternum broad and rounded posteriorly. Tarsi moderately wide; claws barely extending beyond third segment, each having an internal comb, and at least a slight suggestion of an external comb.

Generotype: *Laccoptera excavata* Boheman (South Africa).

Range: Ethiopian and Oriental regions.

KEY TO THE CHINESE SPECIES OF LACCOPTERA

1. Body more or less triangular, strongly narrowed posteriorly and strongly swollen dorsally 2

— Body more rounded, not triangular, feebly narrowed posteriorly, one-half again as long as broad, moderately swollen dorsally and non-tuberculate; pronotum coarsely rugulose .... *L. yunnanica*

2.(1) Dorsal surfaces of body generally with less than 13 distinct spots; pronotum with small round spot on each side of disc; elytral margins with dark patches behind humeri and in posterolateral portions .... *L. quadrimaculata*

— Dorsal surface of body with 13 black spots; pronotum usually immaculate; explanate margins of elytra lacking dark patches; metasternum only slightly pitchy .... *L. tredecimpunctata*

Laccoptera quadrimaculata (Thunberg)

(Plate 35, plate 36, figures 5 and 8)

Laccoptera quadrimaculata THUNBERG, 1789, Nov. Ins. Spec., 5:86, pl. 5, fig. 94[1]. (Type in Upsala University Museum.)

Laccoptera chinensis BOHEMAN *(not* Fabricius), 1855, Mon. Cassid., 3:71[2]; HOFFMANN, 1933, Lingnan Sc. Jl., 12:259, pl. 16.

Laccoptera quadrimaculata subsp. *Bohemani* WEISE, 1910, Verh. Naturf. Ver. Brünn, 48:42[3]; SPAETH, 1913, Ann. Mus. Nat. Hung., 11:46[4]; 1914, Col. Cat., 62:82[5] 1914, Suppl. Ent., 3:15[6]; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 347, fig. 110[7]; SPAETH, 1926, Best.-Tab. Eur. Col., 95:9; CHUJO, 1934, Sylvia, 5:153[8]; GRESSITT, 1938, Lingnan Sc. Jl., 17:191[9], 384[10], 581[11]; 1939, Pan-Pac. Ent., 15:140[12].

Laccoptera Bohemani, SPAETH, 1914, Ent. Mitt., 3:226; 1914, Suppl. Ent., 3:15.

Laccoptera Thunbergi SPAETH, 1914, Suppl. Ent., 3:15 (new name).

BIOLOGY: KERSHAW & MUIR, 1907, Trans. Ent. Soc. London, 1907:290; HOFFMANN, 1933, Lingnan Sc. Jl., 12:259, pl. 16.

Dorsal surfaces testaceous to somewhat reddish, marked with black; pronotum with a small spot on each side of disc some distance from center; elytra each with a spot on anterior portion of common tubercle, an incomplete oblique lateral stripe behind humerus fading out before reaching border of explanate margin, two spots, one behind the other, near center of disc, a large posterolateral spot on explanate margin, one or two spots near top of posterior declivity, and suture black apically; sometimes more extensively marked with black; metasternum black.

Body rounded-triangular in dorsal outline. Pronotum nearly twice as broad as long, deeply striate on disc, irregular on explanate margins. Elytra with disc heavily striate-punctate, with alternate interspaces more strongly raised and joined in places by transverse or oblique ridges. Length 7–9 mm.; breadth 6.6–7.6 mm.

Some (U.S.N.M.) Suifu, 1,000 feet, September, 1924, May, 1928, Tsanghin-shien, 1,200 feet, south of Suifu, May 7, 1924, Yachow, 2,000 feet, July, 1928, and Ning-yuen-fu, 6,000 feet, August 4, 1928, D. C. Graham; (M.C.Z.)

Kiangsu; Yingshien, 1933, Kingloo Shan, August, 1932; Gaines Liu; (C.A.S.) Riran, Formosa, April 19, 1932, Gressitt; (Lingnan) Shaowu, Wingan, March-October, Maa.

Hosts: *Ipomoea Batatas* Lamk., *I. purpurea* Roth.

China: Chekiang[12] (Hangchow); Fukien[10,11] (Foochow, Yen-ping, Kien-yang, Shaowu, Wingan); Kwangtung[10,11] (Canton: White Cloud Mountain, Tsin-leung Shan, Yim-na Shan, Yao Shan, Ts'ing-yuen) Kwangsi (Lung-chow[11]); Sikang (Yachow); Szechuan (Suifu, Ning-yuen-fu); Hainan Island[9,11] (Kachek, Ngai-chau, Nam-fung, Cheung-kon, Tai-pin, Lai-mo-ling, Tai-tsing-lam, Lunghou to Lung-tong, Lok-kei, Ts'ung-to, Hau-ying-ts'uen, Ta-hian, Ta-hau, Liamui, Nodoa); Taiwan[4,6,8] (many localities). Year-round at Canton.

Distribution: South China[2,3]; Taiwan; Indo-China[6,11,12]; Burma[6]; India[7]; East Indies[5]; Andamans[5].

Since the type specimen of *L. quadrimaculata* came from China, and since material from all over South China, as well as neighboring areas, seems to vary within similar limits, the writer sees no justification for the continued use of the subspecific name "*bohemani.*"

Laccoptera tredecimpunctata (Fabricius)

Cassida miliaris Herbst (*not* Fabricius), 1799, Natursyst. Käf., 8:312, pl. 135, fig. 8.

Cassida 13-punctata Fabricius, 1801, Syst. Eleuth., 1:398[1]. (Type in Copenhagen Museum.)

Aspidomorpha philippinensis Blanchard, 1853, Voy. Pole Sud (d'Urville), 4:321, pl. 18, fig. 14[2].

Laccoptera tredecimpunctata, Boheman, 1855, Mon. Cassid., 3:73; Baly, 1863, Jl. Ent., 1:14[3]; Spaeth, 1914, Col. Cat., 62:83[4]; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 350, fig. 112[5]; Gressitt, 1938, Lingnan Sc. Jl., 17:582[6].

Laccoptera 13-punctata, Weise, 1905, Deutsche Ent. Zeits., 1905:123[7].

Reddish brown; pronotum with a pair of round black spots on disc; elytra with five rounded black spots arranged in a zig-zag on disc of each and a common black spot on raised area behind scutellum; ventral surfaces reddish ochraceous marked with blackish on each side of metasternum; antennae pitchy on three distal segments.

Body subtriangular in dorsal outline, rounded posteriorly; fairly convex, gradually declivitous anteriorly and steeply declivitous posteriorly. Prothorax transversely subelliptical, evenly convex anteriorly, sinuately convex posteriorly, rounded at lateral angles; disc finely punctured, sublongitudinally sculptured on central portion. Elytra distinctly broader than prothorax; humeri rounded, fairly prominent; discs densely seriate-punctate, the punctures wider than interspaces, both longitudinally and transversely, except for first, second and fourth interspaces from suture, which are raised;

explanate margins coarsely subrugose-punctate. Length 7 mm.; breadth 5.8 mm.

One (C.A.S.) Hong Kong, 1909, J. C. Thompson.

China: Hainan Island[6]; Hong Kong.

Distribution: India[5]; Thailand[3]; Hainan; Hong Kong; Sunda Islands[1,4]; Philippine Islands[2].

Laccoptera yunnanica Spaeth

Laccoptera yunnanica Spaeth, 1914, Ent. Mitt., 3:226[1]. (Type in Spaeth Collection, Manchester.)

Moderately shiny, brilliant rusty red; dorsum unicolorous or with a pitchy or black spot on explanate margin of each elytron behind middle, or elytral apices also broadly black, or explanate margins with a dark spot behind each humeral angle, and elytral ridges sometimes partly marked with black; metasternum with a pitchy black transverse mark; abdomen with an indistinct black ring mark; antennae with five distal segments pitchy black.

Form weakly subtriangular, broadest just behind humeri, only moderately narrowed posteriorly; about one-half again as long as broad; moderately convex, without tubercles. Prothorax coarsely vermiculate-rugose, with a sub-basal transverse impression extending outward obliquely at each side, behind which base is longitudinally wrinkled; disc strongly swollen anteriorly. Elytra with humeri rounded, much broader than prothorax; explanate margins fairly narrow, moderately declivitous; discs coarsely, deeply and subregularly punctured; second interspace of each elytron raised like a keel and connected by a transverse smooth keel at summit, a similar, weaker keel running externally; explanate margins less coarsely punctured than discs. Tarsal claws smooth externally, with five teeth internally; antennae exceeding angles of prothorax. Length 7–7.5 mm.; breadth 6–6.5.

China: Yunnan[1].

Distribution: Southwest China.

Tribe **CASSIDINI**

Cassidini of authors.

Pronotum not obviously emarginate anteriorly. Tarsal claws never bearing series of comblike teeth on their sides. Prosternum sometimes grooved at sides for reception of antennae.

Genus **Thlaspida** Weise

Thlaspida Weise, 1899, Arch. f. Naturg., 65, 1:272; Spaeth, 1914, Suppl. Ent., 3:16; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 428; Spaeth, 1926, Best.-Tab. Eur. Col., 95:62.

Body strongly convex and rough, bluntly tuberculate behind scutellum; dorsal outline rounded-hexagonal. Head with clypeofrontal area triangular, longer than broad, slightly swollen below antennal insertions. Antennae slender, cylindrical, reaching beyond humeral angles. Prothorax broader than long, much narrower than elytra, subrounded at sides, more strongly convex posteriorly than anteriorly; disc smooth and impunctate. Elytra broadest a short distance behind humeri, which are subangulate; discs strongly and obtusely raised at suture a short distance behind scutellum, surface of each deeply and subseriately punctured and crossed by some irregular subtransverse ridges; explanate margins fairly broad, fully one-half as wide as discs; epipleura of posterior borders of explanate margins bearing extremely fine, posteriorly directed, pale hairs. Tarsi moderately broad; claws just projecting beyond end of third segment, distinctly toothed basally.

Generotype: *Coptocycla cribrosa* Boheman (India; Siam).

Range: India; East Asia.

KEY TO THE CHINESE SPECIES OF THLASPIDA

1. Explanate margins of elytra marked with a dark spot only behind middle, or entirely pale; pronotal disc not depressed anteriorly........ 2

— Explanate margins of elytra marked with dark spots both near humeri and behind middle; pronotal disc very feebly convex anteriorly; explanate margins at apices distinctly less than one-half as wide as greatest width at sides; discs reddish testaceous to partly pitchy........*T. lewisi*

2.(1) Explanate margins at apices about one-half as wide as greatest width at sides; lateral angles of pronotum placed distinctly anterior to median transverse line; discs usually partly pitchy........ 3

— Explanate margins at apices less than one-half as wide as greatest width at sides; lateral angles of pronotum placed very near median transverse line; discs often nearly unicolorous; posterolateral dark patches on explanate margins often lacking; elytral borders evenly rounded posterolaterally........*T. formosae*

3.(2) Elytral borders with distinct obtuse angles posterolaterally, nearly parallel-sided in central portion; explanate margins at apices no more than one-half as wide as greatest width at sides; sides of disc generally reddish brown........*T. biramosa japonica*

— Elytral borders rounded or with very feebly obtuse angles posterolaterally, narrowed posteriorly from anterior to middle of sides; explanate margins at apices often distinctly more than one-half as wide as greatest width at sides; lateral portions of disc often pitchy........*T. biramosa chinensis*

Thlaspida biramosa chinensis Spaeth

(Plate 28, figure 9)

Thlaspida chinensis SPAETH, 1926, Best.-Tab. Eur. Col., 95:641[1]. (Type in Spaeth collection.)

Thlaspida japonica GRESSITT (*not* Spaeth), 1938, Lingnan Sc. Jl., 17:191[2], 385[3], 583[4]; 1939, Pan-Pac. Ent., 15:141[5] (part).

Dorsal surfaces generally highly transparent, hyaline on explanate margins, except for posterolateral brown patch, testaceous, reddish brown or pitchy black on discs, generally darker at sides and pale on median portion behind dorsal tubercle; ventral surfaces pitchy black to largely reddish brown; antennae with distal half pitchy black.

Pronotum not quite twice as broad as long, rounded obtuse at lateral angles, which are placed slightly anterior to middle. Elytra three-fifths again as broad as pronotum, about as broad as long; suture strongly raised between scutellum and tubercle, making latter very obtuse in lateral outline; disc of each elytron with five or six subtransverse connecting ridges; humeri bluntly rounded, bent distinctly inward toward pronotal angles. Length 6.7–10 mm.; breadth 5.5–8.5 mm.

Several (Lingnan and C.A.S.) Shaowu, Chang-ting, Kien-yang, Chungan, April to October, T. C. Maa.

China: Szechuan[1] (Kuanhsien[5]); Kweichow[1]; Hunan (Lam-mo[4]); Kwangtung (Yao Shan, Lien District[4]); Hainan Island[2,4] (Ta-hian, Ta-hau, Ta-han, Cheung-kon, Sam-kwong, Lam-wan-tung, Hau-ying, Tai-po, Tai-tsing-lam); Fukien (near Shanghang[3], Shaowu, Chang-ting, Kien-yang, Chungan). April to October.

Distribution: South and West China; Hainan Island; Indo-China[1].

Thlaspida biramosa japonica Spaeth

? *Coptocycla biramosa* var. *a* BOHEMAN, 1862, Mon. Cassid., 4:464[1].

Coptocycla biramosa, KRAATZ, 1879, Deuts. Ent. Zeits., 23:272[2]; GORHAM, 1885, Proc. Zool. Soc. London, 1885:283[3].

Thlaspida biramosa, WEISE, 1899, Arch. f. Naturg., 65, 1:273[4].

Thlaspida japonica SPAETH, 1914, Suppl. Ent., 3:17[5]; 1914, Col. Cat., 62:127; 1926, Best.-Tab. Eur. Col., 95:63; YOKOYAMA, 1931, (Col. Japan), 2:18, pl. 3, fig. 1; YUASA, 1932, Nippon Konchu Zukan: 585, fig. 144; CHUJO, 1934, Sylvia, 5:155; GRESSITT, 1939, Pan-Pac. Ent., 15:141[6] (except Szechuan). (Type in Spaeth collection, if designated.)

Dorsal surfaces yellowish brown to dark reddish brown: pronotum with disc reddish brown, paler anteriorly, and explanate margins hyaline, subtransparent; elytra dark reddish brown at sides and on anterior portion of dorsal tubercle, reddish on humeral callus and yellow on central portions and transverse ridges; ventral surfaces black, pale along lateral borders; legs and antennae pale, latter with distal halves dusky.

Pronotum less than twice as broad as long, rounded-angulate laterally with lateral angles distinctly anterior to middle. Elytra subparallel at sides, narrowed at humeri and behind posterolateral dark patches, distinctly longer than broad; transverse ridges of discs strongly raised; dorsal tubercle very obtuse; humeral angles bent slightly outward at apices. Length 6.6–8.6 mm.; breadth 5.7–7 mm.

Several (M.C.Z.) Nagasaki and Satsuma, Kyushu, May, 1886, Leech; Nikko, Honshu, August, 1886, G. Smith; and Tai-ping-shien, Anhwei, October, 1932, G. Liu; (C.A.S.) Mt. Takao, Honshu, May 4, 1930, Gressitt.

Host: *Callicarpa japonica* Thunberg (Japan).

China: N. China[5]; Kiangsu (Chinkiang[4]); Chekiang (Hangchow, Mokan Shan[6]); Anhwei (Tai-pin-shien); "China"[1]. May to August.

Distribution: Japan[2,5] (Honshu; Kyushu[3]); northeast China.

After studying numerous series of this complex, the writer is inclined to the conclusion that a widely distributed, highly variable species is concerned, and that until the forms are well known throughout their range, it is not safe to call even specimens from Japan a different species from those inhabiting Sumatra. Within a given area specimens vary greatly, and lines between races may prove very difficult to establish.

Thlaspida formosae Spaeth

Thlaspida formosae SPAETH, 1913, Ann. Mus. Nat. Hung., 11:461[1]; 1914, Suppl. Ent., 3:162[2]; CHUJO, 1934, Sylvia, 5:157[3]. (Type in Budapest Museum.)

Thlaspida formosae ab. *immaculatipennis* CHUJO, 1934, Sylvia, 5:157[4].

Dorsal surfaces partly reddish brown on discs with a large posterolateral dark brown spot on explanate margins of elytra, or entirely orange testaceous with a slight pitchy spot on dorsal tubercle and explanate margins entirely sulphurous hyaline, without dark spots; ventral surfaces reddish brown with metasternum black; legs and antennae pale, latter slightly darkened in distal halves.

Pronotum five-ninths as broad as long, distinctly convex on anterior margin; lateral angles narrowly rounded, placed very near middle in longitudinal sense. Elytra with borders subevenly rounded, giving body a subcircular outline, except for slightly prominent humeral angles; dorsal tubercle large, obtuse; discs with several prominent transverse ridges, giving a partially reticulated arrangement; explanate margins less than twice as broad near apices as at middle of sides.

Some (C.A.S.) Kuraru, near Koshun, August 12–13, 1934, Gressitt.

Hosts: *Callicarpa formosana* Rolfe, *Ipomoea Batatas* Lamk.

China: Taiwan[1,2,3,4] (Kankau, Kuraru, Hokuto, Fuhosho, Takao, etc.).

Distribution: Taiwan.

It is possible that the forms in northern and southern Taiwan may represent different subspecies, in which case Chujo's name "*immaculatipennis,*" although based on a color character, would be available for the latter.

Thlaspida lewisii (Baly)

(Plate 28, figure 8)

Coptocycla Lewisii BALY, 1874, Trans. Ent. Soc. London, 1874:214[1]; GORHAM, 1885, Proc. Zool. Soc. London, 1885:283[2]. (Type in British Museum.)

Coptocycla testacea RYBAKOW, 1884, Hor. Soc. Ent. Ross., 18:136[3].

Thlaspida testacea, SPAETH, 1914, Suppl. Ent., 3:16[4].

Thlaspida Lewisi, SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (145)[5]; DOI, 1927, Dobutsug. Zasshi, 39:337[6]; CHUJO, 1934, Sylvia, 5:155.

Dorsal surfaces brownish and yellowish, marked on explanate margins of each elytron with two large dark spots: one near humerus, other behind middle; elytral discs pitchy brown, darker externally, with ridges yellowish; ventral surfaces pitchy: legs yellowish; explanate margins highly transparent.

Pronotum twice as long as broad, subtriangular, obtusely angulate anteriorly; sides rounded, lateral angles behind middle, in longitudinal sense. Elytra much broader than pronotum, subevenly rounded along margins; humeri rounded, moderately prominent; discs distinctly tuberculate behind scutellum, concave on each side of scutellum, deeply punctate-striate; interspaces raised, particularly near suture in posterior half, crossed by several loosely reticulated subtransverse ridges. Length 7–8 mm.; breadth 7–7.5 mm.

One (Heude) Hsiaoling; (Lingnan) Bohea Hills, April 30, 1940, T. Maa (F. 7741).

China: Manchuria (Hsiaoling); Fukien (Bohea Hills).

Distribution: Amur[4]; Ussuri[3]; East China; Korea[5,6]; Japan (Honshu[1,2]; Hokkaido[2]).

Genus **Glyphocassis** Spaeth

Glyphocassis SPAETH, 1914, Deutsche Ent. Zeits., 1914:547; MAULIK, 1919, Fauna Brit. Ind., Hisp. & Cass.: 359.

Hebdomecosta SPAETH, 1915, Wien. Ent. Ztg., 34:361 (type *H. reitteri); new* synonymy.

Head very strongly oblique, nearly horizontal in front, its outline subrounded in anterior view; frontal area triangular, swollen posterior to antennal insertions, obliquely grooved on each side. Antennae reaching slightly beyond humeri; fairly slender and glabrous in basal half; five distal segments thickened, subcylindrical and hairy. Prothorax transversely oval, broadly rounded laterally; disc even; explanate margins moderately wide and subhorizontal. Elytra rather strongly and evenly convex, seriate-punctate, with relatively narrow and strongly declivitous explanate margins. Prosternal process concave in center, broadly rounded posteriorly; sides of prothorax grooved for reception of antennae. Tarsi fairly slender; claws extending beyond third segment, slender and simple, or somewhat toothed.

Generotype: *Cassida trilineata* Hope (Nepal; Sikkim; Tonkin).

Range: Northern India; South China; Japan. The range of *Glyphocassis* as shown on map 2 should be extended over to southern Japan.

This genus, as augmented, contains four forms, three of them in China. There seems to be no very good reason for maintaining *Glyphocassis* and *Hebdomecosta* as separate genera. The character of the tarsal claws toothed versus untoothed is not alone sufficient to separate otherwise apparently perfectly congeneric species. Furthermore, the claws have at least a suggestion of teeth in *G. lepida.*

KEY TO THE CHINESE SPECIES OF GLYPHOCASSIS

1. Elytra rather strongly convex; body more than two-fifths as deep as long, broadly ovate; pronotal disc largely pale 2

— Elytra not strongly convex; body less than two-fifths as deep as long, suboblong and subparallel-sided; pronotal disc largely black .... *G. trilineata szechuana*

2. Pronotum obtusely arcuate anteriorly; pronotum finely punctulate with three feeble basal black markings; each elytron with suture narrowly and evenly black and with only one or two very small discal spots .... *G. lepida*

— Pronotum evenly arcuate anteriorly; pronotum with very minute punctures, with three large basal black markings; each elytron with suture edged with a series of black spots and with three large oblique black discal markings .... *G. spilota*

Glyphocassis lepida (Spaeth), new combination

(Plate 29, figure 8)

Coptocyla lepida SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64:(145)[1]. (Type in Spaeth collection, Manchester.)

Hebdomecosta lepida, SPAETH, 1915, Wien. Ent. Ztg., 34:363.

Glyphocassis tetrasticta GRESSITT, 1942, Lingnan Nat. Hist. Surv. & Mus. Spec. Publ., 5:3, fig. 3[2]; new synonymy. (Type in W.C.U.U.)

Dorsal surfaces reddish brown, a large black spot near each posterolateral angle of pronotum, a short longitudinal line anterior to scutellum, and scutellum, black, each elytron with suture, basal margin, a small line on base of fourth puncture-row, a median line external to fourth puncture-row, and an oblique spot behind middle of explanate margin, of black; ventral surfaces black with outer margins of abdominal segments dark rust-red; head brownish red; legs reddish with bases of femora pitchy black; antennae brownish red.

Ovate, one-half again as long as broad, hardly widened at sides, strongly swollen, non-tuberculate. Head with frons triangular, narrowed at antennal insertions. Antennae with ninth segment reaching base of prothorax, six basal segments slender and shiny, the remainder thicker, hairy. Prothorax transversely elliptical, with sides broadly rounded, widest at middle, swollen and microscopically punctulate on disc. Elytra one-sixth broader at base than prothorax, with humeri prominent, disc of each with ten rows of fine, deep punctures, the rows narrower than the smooth interstices; explanate margins declivitous, vaguely punctured; claws untoothed. Length 4.7 mm.; breadth 3.5 mm.

Specimens (M.C.Z.) Chang-yang, altitude 4–6,000 feet, near Ichang, July 1887, and Kiukiang, June 1887, A. E. Pratt; (U.S.N.M.) Hua-yin Shan, 2,500 feet, 70 miles north of Chungking, July 5, 1933, D. C. Graham.

China: Sikang (Lingkuan[2]); Szechuan (Chungking[1], Hua-yin Shan) Kiangsi (Kiukiang); Hupeh (Chang-yang).

Distribution: South China.

Glyphocassis spilota (Gorham), new combination

Coptocycla spilota Gorham, 1885, Proc. Zool. Soc. London, 1885:285[1]; Spaeth, 1926, Best.-Tab. Eur. Col., 95:66. (Type in British Museum.)

Hebdomecosta reitteri Spaeth, 1915, Wien. Ent. Ztg., 34:362[2]; Gressitt, 1939, Pan-Pac. Ent., 15:143[3]. (Type in Spaeth collection, Manchester.)

Metriona spilota, Chujo, 1934, Sylvia, 5:159.

? Glyphocassis trilineata Liu (*not* Hope ?), 1936, Lingnan Sc. Jl., 15:261[4].

Hebdomecosta spilota, Spaeth, 1942, Arb. Morph. Tax. Ent. Berlin, 9:12.

Rich reddish castaneous with explanate margins ochraceous, marked with black as follows: pronotum with posterolateral angles, an adjacent spot on middle of each side of basal margin, touching the former, a broad median stripe from center of disc to scutellum, and a triangular spot above head, scutellum black, elytra with suture, some small irregular adjacent spots, three oblique spots on each disc and two marginal spots on each, one behind humeri, other behind middle; antennae, head and legs ochraceous; ventral surfaces black except for prothoracic pleura and borders of abdomen.

Small, rounded-oval, strongly convex. Antennae distinctly thickened distally, reaching to just beyond elytral humeri; frons convex, rough and punctured; prothorax about twice as broad as long, rounded anteriorly and laterally, sinuate basally, produced opposite scutellum, smooth though shallowly punctured on disc; scutellum short, triangular; elytra strongly convex, with explanate margins steeply declivitous anteriorly, broadest near middle, not very prominent at humeri, which are rounded and only slightly broader than prothorax; discs fairly smooth and even, shallowly and subregularly punctured. Length 4.6 mm.; breadth 3.75 mm.

One (Heude) Zikawei, April 28, 1917; many (Lingnan & C.A.S.) Ta-chu-lan, Shaowu, April to June, 1942–43, T. Maa; Kuatun, May, Klapperich.

China: Shantung ? ("Kiautschau"[2]); Kiangsu[4] (Shanghai); Chekiang (Hangchow[3]); Fukien (Shaowu, Kuatun).

Distribution: Eastern China; Japan (Honshu[1]).

Glyphocassis trilineata szechuana Gressitt, new subspecies

(Plate 28, figure 7)

Body reddish ochraceous, extensively marked with black: head pitchy reddish; antenna ochraceous on basal half, blackish distally; pronotum with explanate margin amber-colored with a broad pitchy black area just anterior to each posterolateral angle, and disc blackish with each side, and a round spot on either side of midline behind center, dull reddish; scutellum black; each elytron with explanate margin ochraceous amber with an incomplete pitchy spot on humeral portion and a larger black spot on posterolateral portion, and with disc black with spots of reddish ochraceous: three basal, of which humeral and middle one minute, two obliquely placed, anterior to middle, the hinder one larger and not far from suture, two more obliquely placed behind middle, subequal, the hinder one close to suture, and finally parts of extreme apex, and a small indentation on middle of side of disc, also pale; ventral surfaces pitchy black with outer borders of abdomen reddish; legs pitchy tinged with reddish.

Head round; frons trapeziform, convex, deeply punctured, obliquely grooved on each side. Antenna reaching slightly beyond humeral angle of elytron, slender basally, thickened distally; third to fifth segments subequal, each much longer than second; eighth to tenth each about as broad as long. Prothorax about twice as broad as long, evenly rounded anteriorly; disc convex and impunctate. Elytra about one-sixth broader than prothorax, subparallel-sided; disc of each subevenly convex, with ten rows of punctures, the punctures mostly fine and not very closely spaced; but in part larger in middle rows anterior to center, and on sides. Ventral surfaces striate on prosternum and metasternum, closely punctulate on metepisternum and sparsely punctured on abdomen. Tarsal claws moderately toothed. Length 5.5 mm.; breadth 4 mm.

Holotype (Lingnan Nat. Hist. Mus.) **Pe-pei, North of Chungking, eastern Szechuan Province, West China,** July 29, 1940, Gressitt, on sweet-potato; paratopotype (C.A.S.), July 27.

Differs from *G. trilineata* (Hope), of northern India, in having the pronotum more convex with its sides more steeply declivitous and with the black pigmentation more extensive, extending forward in a point above head and with a large marginal spot on each side, and with the elytra less evenly convex, with a depression on each side anterior to middle, more strongly punctured, and with a fairly large humeral spot on each explanate margin.

Distribution: West China.

Genus **Ischyronota** Weise

Ischyronota WEISE, 1893, Naturg. Ins. Deutschl., 6:1069; Reitter, 1901, Wien. Ent. Ztg., 20:103; JACOBSON, 1901, l. c.: 125.

Form very strongly convex, with explanate margins strongly declivitous; body narrowed posteriorly. Antennae hardly reaching beyond posterior margin of prothorax; second and third segments subequal in length. Pronotum subtriangular, subtruncate basally, narrowed anteriorly, truncate or briefly rounded apically. Elytra strongly convex; explanate margins steeply declivitous, separated from discs by an impressed line; discs irregularly punctured. Tarsi moderately broad; claws somewhat projecting beyond lobes of third segment, lacking basal teeth.

Generotype: *Cassida desertorum* Gebler (central Asia).

Range: Southeast Europe; central Asia.

KEY TO THE CHINESE SPECIES OF ISCHYRONOTA

1. Prothorax almost longer than broad; length of body 5 mm................*I. conicicollis*
— Prothorax distinctly broader than long; dorsal surfaces of body partly rose-red; length 4–5.5 mm..*I. desertorum*

Ischyronota conicicollis (Weise)

Cassida conicicollis WEISE, 1890, Horae Soc. Ent. Ross., 24:487[1]. (Type in Moscow Museum ?)

Ischyronota conicicollis, REITTER, 1901, Wien. Ent. Ztg., 20:108; JACOBSON, 1901, t. c.: 127; SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.):144[2].

Dorsal surfaces green, slightly shiny; ventral surfaces brownish yellow; legs green.

Body slender, subovate; strongly convex; occiput smooth or with isolated punctures; prothorax as long as broad, trapeziform, strongly narrowed anteriorly, with large, shallow punctures; elytra more than one-half again as long as broad, narrowed behind the prominent humeri, either with regular rows of deep punctures or with confused puncture-rows. Length 5 mm.

China: Central Mongolia (Gobi Desert[1]); Sinkiang (Kuldja, Tien Shan[2]). August.

Distribution: Transcaspia to Mongolia.

Ischyronota desertorum (Gebler)

Cassida desertorum GEBLER, 1833, Bull. Soc. Nat. Moscou, 6:305[1]. (Type in Moscow Museum.)

Cassida gibbula BOHEMAN, 1854, Mon. Cassid., 2:430 (Turcomania).

Cassida salsolae (Becker ms.) GEMMINGER & HAROLD, 1874, Cat. Col., 12:3653[2]; DESBROTHERS, 1891, Mon. Cassid.: 42.

Cassida Jakowlewi REITTER, 1889, Deutsche Ent. Zeits., 1889:288.

Cassida desertorum ab. *araxicola* REITTER, 1889, l. c.[3].

Ischyronota desertorum, JACOBSON, 1901, Wien. Ent. Ztg., 20:125; SPAETH, 1914, Col. Cat., 62:87[4].

Ischyronota desertorum ab. *basimargo* REITTER, 1901, Wien. Ent. Ztg., 20:108[5].

Pale greenish; pronotum pale, tinged with rosaceous anteriorly and on margins; scutellum reddish; elytra variegated with reddish. Ovate; antennae thickened distally, last segment acuminate; prothorax semicircular, deflexed laterally and anteriorly, bisinuate basally; pronotum strongly convex in center, finely punctulate; scutellum large, triangular; elytra broader than prothorax, longer than broad, narrowed posteriorly, reflexed beyond middle; humeri prominent, tuberculate; discs vaguely punctulate, subseriately near suture; ventral surfaces punctured. Length 3.5 mm.; breadth 2 mm.

China: Central Asia[4].

Distribution: Southern Russia[1,2,3,5] to central Asia[4].

Genus **Chiridopsis** Spaeth

Deloyala CHEVROLAT, 1837, in Dejean, Cat. Col., ed. 3:371, 395 (part).

Chirida WEISE, 1896, Deutsche Ent. Zeits., 1896:12 (part); SPAETH, 1914, Col. Cat. 62:124 (part); MAULIK, 1919, Fauna Brit. Ind., Hisp. Cass.: 412.

Chiridopsis SPAETH, 1924, Voy. Alluaud et Jeannel Afrique Or., 18:337.

Body subcircular in dorsal outline, strongly convex, subrounded above. Prothorax grooved at sides for reception of antennae. Tarsal claws strongly toothed basally.

Head covered by pronotum, rounded-oval in anterior outline; strongly oblique in lateral outline; mouthparts largely exposed; fronto-clypeal area trapeziform, emarginate on inferior margin, broader than long, subevenly convex. Antennae attaining or slightly exceeding humeral angles of elytra, slender and cylindrical in distal third; last segment acuminate; scape longer than third segment; fourth as long as, or longer than, third or fifth. Prothorax grooved on each pleuron for reception of antennae; ridge on outer side of groove not reaching as far posteriorly as lateral angle of acetabulum; pronotum narrower than elytra, transversely oval, produced opposite scutellum; disc convex and even; explanate margins subhorizontal, raised above head, smooth, almost as large, in area, as disc. Scutellum equilaterally triangular. Elytra subevenly convex, feebly swollen behind scutellum, subregularly punctured on discs; explanate margins about one-half as wide as discs, declivitous at an angle of about forty-five degrees at sides. Prosternum nearly twice as wide posteriorly as between acetabula, obtusely rounded posteriorly. Tarsi one-third as broad as long; claws strongly toothed basally.

Generotype: *Chirida aubei* Boheman (Africa).

Range: Oriental and Ethopian regions.

Key to the Chinese Species of Chiridopsis

1. Each elytron marked with three rounded discal spots of black; pronotal disc and scutellum reddish .... *C. bowringii*

— Elytral discs black with a number of small irregular roundish spots of yellowish testaceous on each, partly fused; scutellum dull testaceous .... *C. punctata*

Chiridopsis bowringii (Boheman)

(Plate 29, figure 2)

Coptocycla Bowringii Boheman, 1885, Mon. Cassid., 2:123[1]. (Type in Stockholm Museum.)

Chirida bowringii, Maulik, 1913, Rec. Ind. Mus., 9:116[2]; 1919, Fauna Brit. Ind., Hisp. & Cass.: 416[3]; Gressitt, 1938, Lingnan Sc. Jl., 17:193[4], 589[5].

Chirida Bowringii, Spaeth, 1914, Col. Cat., 62:125[6].

Chiridopsis Bowringii, Spaeth, 1930, Cat. Col. Reg. Palaearct., 2:1359.

Dorsal surfaces yellowish testaceous, marked with black and red: pronotal disc almost entirely red, narrowly bordered with black basally; scutellum red; elytra black along suture; disc of each with three large rounded black spots, first on humeral callus, second near suture at middle, third placed posterolaterally; ventral surfaces entirely testaceous; terminal antennal segments slightly pitchy.

Body rounded-oval in dorsal outline, broadest near middle, about one-half as deep as broad. Pronotum two-thirds again as broad as long, convex, impunctate. Elytra regularly punctured in ten rows of widely spaced small punctures on each. Antennae reaching slightly beyond elytral humeri, which are directed downward. Length 5.4–6.8 mm.; breadth 4.8–5.5 mm.

China: Hong Kong[1]; Kwangtung (White Cloud Mountain[5]); Hainan Island[4,5] (Ta-hian, Cheung-kon, Tai-ping, Tai-tsing-lam-ts'uen, Sam-kwong-ts'uen, Nam-fung, Ch'ung-mei, Nam-cha-chuen). April to November.

Distribution: South China; Hong Kong; Hainan; Tonkin[6]; Burma[2,3].

Chiridopsis punctata (Weber)

(Plate 29, figure 1)

Cassida punctata Weber, 1801, Obs. Ent., 1:51[1].

Cassida punctaria Fabricius, 1801, Syst. Eleuth., 1:392[2]; Olivier, 1808, Ent., 6:965; 97, pl. 6, fig. 90.

Coptocycla punctaria, Boheman, 1855, Mon. Cassid., 3:254; Baly, 1863, Jl. Ent., 2:14[3].

Chirida punctaria, Weise, 1897, Deutsche Ent. Zeits., 1897:108.

Chirida punctata, Spaeth, 1914, Col. Cat., 62:125[4]; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 415[5]; Gressitt, 1938, Lingnan Sc. Jl., 17:193[6], 589[7].

Dorsal surfaces shiny yellow, marked with black: pronotal disc with two arcuate marks near base which fuse to form an inverted "W"; disc of each elytron black with numerous partly coalescent medium-sized yellow spots, and external portions largely yellow; ventral surfaces and appendages entirely testaceous.

Dorsal outline rounded-oval, broadest at middle, not quite one-half as deep as broad. Pronotum two-thirds again as broad as long, moderately convex, microscopically punctulate. Elytra with discs finely punctured in ten longitudinal rows, punctures irregularly spaced, practically lacking on yellow spots. Antennae reaching to just beyond elytral humeri. Length 5.8–6.7 mm.; breadth 5–5.8 mm.

One (Lingnan) Nam-kio, February 1947.

China: Kwangtung (Yao Shan[7]); Hainan Island[6,7] (Nodoa, Nam-fung, Cheung-kon, Tai-pin, Nam-liu-tin, Sam-kwong-ts'uen, Tun-heung-ts'uen, Lok-kei, Kan-sho, Poh-shang, Nam-kio). March to November.

Distribution: Burma[5]; South China; Hainan; Indo-China[3,4]; Thailand[3]; Sunda Islands[1,2].

The Chinese material may possibly represent the subspecies *D. punctata indochinensis* Spaeth (1919, Ann. Mus. Nat. Hung., 17:199) if the latter is a valid subspecies.

Genus **Cassida** Linnaeus

Cassida Linnaeus, 1758, Syst. Nat., ed. 10, 1:362; Fabricius, 1801, Syst. Eleuth., 1:387; Suffrian, 1844, Stett. Ent. Ztg., 5:49; Boheman, 1854, Mon. Cassid., 2:329; Chapuis, 1875, Gen. Col., 11:338; Weise, 1893, Ins. Deutschl., 6:1070; Reitter, 1912, Fauna Germ., 4:213; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.:361; Spaeth, 1926, Best.-Tab. Eur. Col., 95:23.

Cassidula, Coptocycla, Deloyala, Metriona, Mionycha, Odontionycha, Taiwania, Tylocentra, see subgenera, below.

Body rounded to elliptical or trapeziform in dorsal outline, fairly flat to strongly convex. Head with mouthparts largely visible. Antennae short to fairly long. Pronotum broader than long, completely covering head. Elytra punctured, often uneven, with distinct explanate margins, which are rarely very steeply declivitous; epipleurae lacking long fine hairs at extreme apices. Posternum lacking distinct grooves for reception of antennae. Tarsal claws toothed or not toothed basally, never with lateral combs.

Generotype: *Cassida nebulosa* Linnaeus (Palearctic region).

Range: Old World.

Key to the Chinese Subgenera of Cassida

1. Elytral discs generally strongly convex; explanate margins of elytra more than one-half as wide at middle as elytral discs, transparent and unpigmented in central portion; suture often raised into a tubercle behind scutellum; tarsal claws toothed (except in *Lasiocassis)*.............................. 2

— Elytral discs rarely strongly convex; explanate margins of elytra generally less than one-half as wide at middle as elytral discs, opaque or feebly transparent, generally pigmented similarly to disc; suture rarely raised into a distinct tubercle behind scutellum; tarsal claws not toothed (toothed in *Odontionycha*) 3

2.(1) Tarsal claws not toothed; body pentagonal in dorsal outline, very strongly tuberculate at summit of elytra; elytral discs coarsely rugose; explanate margins of elytra heavily and broadly pigmented at humeral and posterolateral angles .... *Lasiocassis*

— Tarsal claws more or less distinctly toothed; body oval or subrounded in dorsal outline, always rounded posteriorly, generally feebly tuberculate at summit of elytra; elytral discs at most feebly rugose; explanate margins rarely very broadly pigmented at either humeral or posterolateral angles.......... *Taiwania*

3.(1) Tarsal claws not toothed basally.......... 4

— Tarsal claws toothed basally; body broad and flat.......... *Odontionycha*

4.(3) Tarsal claws strongly divergent, not minute, projecting at least slightly beyond end of lobes of third tarsal segment, not hidden by hairs of latter 5

— Tarsal claws narrowly divergent, minute, hidden by hairs of third tarsal segment; frontoclypeal area with central portion narrowly triangular; elytra regularly seriate-punctate .... *Mionycha*

5.(4) Explanate margins of elytra steeply declivitous, generally projecting farther interior than ventral surfaces of body, forming a concavity.......... 6

— Explanate margins of elytra feebly declivitous; body generally broadly oval or oblong and flattened.......... *Cassida*

6.(5) Elytra evenly convex; third interpunctural area with scattered punctures; middle coxae close together; ventral surfaces largely black.......... *Cassidula*

— Elytra moderately tuberculate at summit; third interpunctural area lacking punctures; middle coxae widely separated; ventral surfaces green or yellow .... *Tylocentra*

Subgenus **Lasiocassis** Gressitt, new subgenus

Deloyala Redtenbacher (*not* Chevrolat), 1858, Fauna Austr., ed. 2:952; 1874, Fauna Austr., ed. 3, 2:520; Weise, 1893, Ins. Deutschl., 6:1076; Spaeth, 1926, Best.-Tab. Eur. Col., 95:15, 61; Chujo, 1934, Sylvia, 5:167; Liu, 1936, Lingnan Sc. Jl., 15:258.

Body subpentagonal in dorsal outline, obtuse anteriorly, narrowed posteriorly, subtransverse apically; sides fairly straight. Pronotum transverse, broadly rounded at middle of each side. Elytra strongly convex, strongly tuberculate at summit; discs coarsely subreticulate-rugose. Tarsal claws untoothed, widely divergent and projecting beyond lobes of third tarsal segment.

Subgenerotype: *Cassida vespertina* Boheman (eastern Palearctic).

Range: Southern and eastern portions of Palearctic region.

In addition to the type, this subgenus includes *Cassida seraphina* Menetries and *C. hablitziae* Motschulsky (*C. testudo* Suffrian).

Cassida (Lasiocassis) vespertina (Boheman)

Cassida vespertina Boheman, 1862, Mon. Cassid., 4:357[1]; Baly, 1874, Trans. Ent. Soc. London, 1874:213[2]; Gorham, 1885, Proc. Zool. Soc. London, 1885:282. (Type in Stockholm Museum.)

Deloyala vespertina, Weise, 1900, Arch. f. Naturg., 66, 1:295[3]; Spaeth, 1914, Suppl. Ent., 3:19[4]; 1926, Best.-Tab. Eur. Col., 95:61[5]; Yokoyama, 1931 (Col. Japan), 2:19, pl. 3, fig. 4; Yuasa, 1932, Nippon Konchu Zukan: 586, fig. 1145; Liu, 1936, Lingnan Sc. Jl., 15:258; Gressitt, 1938, op. cit., 17:586[6].

Cassida (Deloyala) vespertina, Spaeth, 1914, Col. Cat., 62:95; Chujo, 1934, Sylvia, 5:168[7]; Gressitt, 1939, Pan-Pac. Ent., 15:142[8].

Dorsal surfaces black to pitchy brown except for central two-thirds of anterior portion of explanate margin of pronotum, middle third of explanate margin of each elytron and a small area on apical margin of each near suture; scutellum sometimes brown; ventral surfaces testaceous brown to pitchy black; head and basal half of antennae testaceous; apical half of antennae dusky; legs testaceous with femora dusky basally.

Dorsal outline subtrapeziform, broader anteriorly; rather strongly convex; tuberculate behind scutellum. Pronotum fully twice as broad as long, evenly rounded laterally, produced and truncate opposite scutellum, finely punctured on both disc and explanate margin, subvermiculate on sides of disc. Elytra rough, strongly tuberculate with a laterally bifurcating and rebranching transverse ridge on each, and some other swellings or ridges; punctures close and transverse, seriate except for interruptions; explanate margins rough. Length 4.7–6.7 mm.; breadth 4–5.8 mm.

Some (Lingnan) Ta-chu-lan, Shaowu, April-June, Maa; (M.C.Z.) Chang-yang, near Ichang, 4–6,000 feet, July 1887, A. E. Pratt; Ching-cheng Shan, July 1932, G. Liu; (Heude) Yang-kia-ping, July 1937; (C.A.S.) Mt. Takao, near Tokyo, May 4, 1930, Chirifu, near Rokki, May 18, 1934, Hassensan, June 25, 1934, and Musha, August 24, 1947, Taiwan, Gressitt; (U.S.N.M.) Muping (Moupin) 7,000–13,000 feet, July 6, 1929, D. C. Graham.

Hosts: According to the writer's recollection, this species probably feeds on thistles or other Compositae.

China: Mongolia[5]; North China[1]; Chahar (Yang-kia-ping); Szechuan[5] (Kuanhsien, Ching-cheng Shan); Sikang (Moupin); Hupeh (Chang-yang) Formosa[4,7] (numerous localities); Hunan (Lam-mo[6]); Kwangtung[6] (Yao Shan; Lien-ping); Fukien (Shaowu); Chekiang[8] (Mokan Shan, Hangchow). April to August.

Distribution: Amur[3]; Ussuri[5]; China; Formosa; Korea[5]; Japan[2]; Ryukyu Islands[7] (Miyako, Ishigaki).

Subgenus **Taiwania** Spaeth

Coptocycla of authors. (Old World species, part.)

Metriona of authors. (Old World species, part or all.)

Taiwania Spaeth, 1913, Ann. Mus. Nat. Hung., 11:48.

Body rounded-ovate in dorsal outline, generally very little longer than broad. Antennae generally reaching well beyond humeral angles of elytra. Pronotum transverse, broadly rounded laterally, rarely punctured. Elytra more or less swollen at suture behind scutellum; discs rather strongly convex, more or less seriate-punctuate, sometimes partly rugulose; explanate margins more than one-half as wide as discs at middle, almost always at least subtransparent in central portions. Tarsal claws widely separated, more or less distinctly toothed basally.

Subgenerotype: *Taiwania sauteri* Spaeth (Indo-Chinese subregion).

Range: Oriental region and probably also Ethiopian and Australian regions.

The name *Taiwania,* founded as a genus by Spaeth for a Taiwan species *(T. sauteri* Spaeth), has heretofore been used for only three species (from Taiwan, South China, and Indo-China), two of which have been united. The writer believes that this name is available for use in a subgeneric sense for all or most of the species from Asia and Africa placed in *Metriona* and some of those still assigned to *Coptocyola* or *Cassida.*

KEY TO THE CHINESE SPECIES OF TAIWANIA

1\. Explanate margins of elytra each with a dark humeral area or dark basal margin 2

— Explanate margins of elytra lacking humeral dark spots 7

2.(1) Explanate margins of elytra lacking a posterolateral dark spot 3

— Explanate margins of elytra each with a posterolateral dark spot 4

3.(2) Explanate margin of each elytron with a narrow oblique basal spot separated from basal margin by a pale border nearly as wide as dark spot; elytra twice as wide as pronotum, lacking coarse transverse rugae .... *T. eoa*

— Explanate margin of each elytron with a broad basal area touching basal margin; elytra much less than twice as wide as pronotum, with coarse transverse or oblique rugae on discs .... *T. sigillata*

4.(2) Puncture-rows of elytral discs narrower than interpunctural areas; body generally more than six mm. in length 5

— Puncture-rows of elytral discs fully as wide as interpunctural areas; body less than six mm. in length; elytra with a moderate, obtuse tubercle at summit .... *T. quadriramosa*

5.(4) Elytral discs without a distinct postscutellar tubercle 6

— Elytral discs with a prominent postscutellar tubercle, without distinct black spots, not entirely smooth; punctures subfoveate, blunt .... *T. rati*

6.(5) Explanate margin of each elytron narrowly black on basal margin; elytral disc with a distinct black spot on humeral callus and a spot at summit of suture; disc smooth with fine punctures .... *T. purpuricollis*

— Explanate margin of each elytron broadly black on basal margin; elytral disc without a distinct black spot on humeral callus or on summit, but with irregular spots, particularly at sides; pronotum almost entirely pale........ *T. amurensis*

7.(6) Pronotum narrowed and angulate at each side, not broadly rounded; humeri meeting sides of pronotum rather closely, both as regards external margin and inclination 8

— Pronotum broadly rounded at each side; humeri not meeting sides of pronotum very closely, projecting and inclined somewhat at a steeper angle 14

8.(7) Pronotum slightly punctured; body less than 5 mm. in length; explanate margins of elytra punctured........ 9

— Pronotum impunctate; body generally more than 5 mm. in length; explanate margins of elytra impunctate........ 11

9.(8) Head sparsely or indistinctly punctured; lateral angles of pronotum nearly right angles 10

— Head finely and closely punctured; lateral angles of pronotum obtuse; dorsum yellowish with elytral punctures brown; elytral punctures widely and irregularly spaced........ *T. juno*

10.(9) Explanate margins of elytra more than one-half as wide as discs at middle, fully one-half as wide at apices as at widest portions; elytral discs marked with black .... *T. imitatrix*

— Explanate margins of elytra hardly one-half as wide as discs at middle, much less than one-half as wide at apices as at widest portions; elytral discs entirely pale .... *T. obtusata*

11.(8) Elytra with a raised X-shaped area astride suture at summit, which is often paler than rest of surface........ 12

— Elytra lacking a raised X-shaped area astride suture at summit........ 13

12.(11) Explanate margins of elytra nearly three-fourths as wide as respective discs; pronotal disc evenly convex........ *T. expansa*

— Explanate margins of elytra barely over one-half as wide as respective discs; central portion of pronotal disc more strongly convex than remainder; posterolateral portion of elytral explanate margin often with a dark band........ *T. versicolor*

13.(11) Sides of elytral discs and explanate margins steeply and subevenly declivitous; dorsum entirely pale or with a prominent U-shaped black mark on elytra .... *T. circumdata*

— Sides of elytral discs and explanate margins not equally declivitous, forming a strong angle with each other; dorsum greenish yellow with black spots........ *T. plausibilis*

14.(7) Body oblong-scutiform in dorsal outline, broadest at humeral angles, narrowed posteriorly, more than six mm. in total length........ 15

— Body rounded oval or rounded oblong, broadest behind humeri, less than six mm. in total length........ 16

15.(14) Fifth and sixth puncture-rows not very deeply impressed behind middle; pronotum more than twice as broad as long, distinctly more convex anteriorly .... *T. sauteri*

— Fifth and sixth puncture-rows deeply impressed behind middle; pronotum not quite twice as broad as long, transversely symmetrical........ *T. spaethiana*

16.(14) Dorsal surfaces entirely testaceous or greenish; ventral surfaces black with abdomen bordered with pale 17

— Dorsal surfaces spotted or extensively marked with black; head and abdomen, or head and thoracic sterna, reddish or yellow, or ventral surfaces entirely pale 18

17.(16) Pronotum one-half as long as broad; dried specimens partly greenish; puncture-rows as broad as interpunctural areas; second interpunctural area slightly raised .... *T. expressa*

— Pronotum three-fifths as long as broad; dried specimens not partly greenish; puncture-rows narrower than interpunctural areas; a raised crescent on each side of summit of elytra; explanate margins undulating........ *T. juglans*

18.(16) Pronotal and elytral discs almost entirely black; pronotum twice as broad as long; lateral outline slightly convex between summit of elytra and anterior border of pronotum; puncture-rows completely regular at central portions of sides of elytra........ *T. discalis*

— Pronotal disc entirely pale; elytral discs black with two irregular, broad oblique bands, and outer border, on each, yellowish; lateral outline straight or partly concave between summit of elytra and another border of pronotum; puncture-rows somewhat confused or interrupted at central portions of sides of elytra .... *T. insulana*

Cassida (Taiwania) amurensis (Kraatz), new combination

(Plate 29, figure 9)

Coptocycla amurensis Kraatz, 1879, Deutsche Ent. Zeits., 23:141[1].

Metriona amurensis, Spaeth, 1914, Cat. Coleopt., 62:142; Spaeth & Reitter, 1926, Best.-Tab. Eur. Col., 95:65.

Dried specimens pale ochraceous, moderately transparent on sides of elytral explanate margins; pronotal disc with a faint pitchy mark on center; each elytral disc with humeral and posterolateral angles prominently black, and with a number of irregular blackish spots on disc; head and sides of abdomen pale; rest of ventral surfaces black; legs largely pale.

Head with frontoclypeus raised distally, grooved laterally. Antennae long; third segment much longer than second. Prothorax more than twice as broad as long, broadly rounded at sides, nearly flat. Elytra distinctly broader than prothorax, broadest slightly behind humeral angles; disc of each with fairly regular rows of moderate punctures which are distinctly narrower than interpunctural strips. Length 6.8–8 mm.; breadth 5.6–6.5 mm.

One (Heude) Hsiao-ling, August 16, 1938.

China: Manchuria (Hsiao-ling).

Distribution: Southeastern Siberia (Ussuri[1]); northeastern China.

Cassida (Taiwania) circumdata Herbst

(Plate 28, figure 2; plate 36, figures 6 and 9)

Cassida circumdata Herbst, 1790, Natursyst. Käf., 8:268, pl. 132, fig. 11[1]; Olivier, 1808, Ent., 6:967; 97, pl. 6, fig. 93; Boisduval, 1835, Faune Ent. de l'Oceanie

(Astrolabe), 2:536; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 404[2]. (Type in Berlin Museum ?.)

Cassida trivittata Fabricius, 1801, Syst. Eleuth., 1:397[3]; Olivier, 1808, Ent., 6:973; 97, pl. 6, fig. 103; Blanchard, 1853, Voy. Pole Sud (d'Urville) Zool., 4:323, pl. 18, fig. 16.

Cassida U-fuscum Wiedemann, 1823, Zool. Mag., 2:74.

Coptocycla circumdata, Boheman, 1855, Mon. Cassid., 3:279; Baly, 1863, Jl. Ent., 2:14[4]; Schönfeldt, 1890, Ent. Nachr., 16 (11):175.

Coptocycla trivittata, Boheman, 1855, Mon. Cassid., 3:280[5].

Coptocycla luzonica (Eschscholtz ms.) Gemminger & Harold, 1874, Cat. Col., 12:3667[6].

Metriona circumdata, Weise, 1901, Deutsche Ent. Zeits., 1901:53; Spaeth, 1903, Ann. Mus. Nat. Hung., 1:128; 1913, op. cit., 11:47[7]; Maulik, 1913, Rec. Ind. Mus., 9:114; Miwa, 1933, Trans. N. H. Soc. Formosa, 23: 12[8]; Liu, 1936, Lingnan Sc. Jl., 15:261[9]; Chujo, 1934, Sylvia, 5:161[10]; Gressitt, 1938, Lingnan Sc. Jl., 17:191[11], 386[12], 584[13]; 1939, Pan-Pac. Ent., 15:141[14].

Metriona circumdata ab. *pescadorensis* Chujo, 1934, Sylvia, 5:162[15].

Cassida cuticula Gressitt, 1938, Lingnan Sc. Jl., 17:191[16].

Biology: Schultze, 1908, Philip. Jl. Sc., B, 3:267: pl. 5, figs. 4–8, pl. 6, fig. 4[17]; Yeung, 1935, Lingnan Sc. Jl., 14:143[18].

Dorsal surfaces golden green in life, with or without black markings. Dried specimens either entirely testaceous or marked with black along median line from basal portion of pronotal disc to midpoint of elytral suture, and with a large, irregular, common U-shaped mark on outer portions of discs, the arms ending on humeral calli; antennae, legs, and ventral surfaces pale testaceous.

Dorsal outline rounded-oval; body strongly convex. Pronotum two-thirds as long as broad, rounded-angulate at middle of each side; disc smooth. Elytra each with ten regular puncture-rows; interspaces partly swollen near suture; explanate margins rather steeply declivitous. Length 4.2–5.6 mm.; breadth 3.2–4.7 mm.

Many (Lingnan) Shaowu, Wingan, Shanghang, Kienin, Len-cheng, March-September, Fukien, Maa; An-yuen, May, Kiang-ching, July, Gressitt & Djou; (A.M.N.H.) Yen-ping, Spring, 1915, June 17–20, 1927; (M.C.Z.) Foochow, April, 1886, Leech; (C.A.S.) Chizuka, Okinawa, 1945, G. Bohart.

Hosts: *Ipomoea palmata* Forst[17], *I. Batatas* Lamk., *I. aquatica* Forsk, *I. cairica* Sweet, *I. digitata* Linn[18].

China: Szechuan (Kiang-ching); Kiangsi (An-yuen); Fukien[12,13] (Amoy[9], Yen-ping, Foochow, Shaowu, etc.); Kwangtung[12,13] (Yim-na Shan, Swatow[14], Canton, Shek-lung, Yao Shan, Meu-ming, Lien, Lo-ting and Ts'ing-yuen Districts, Tung-kwan); Hong Kong[13]; Kwangsi (Nanning); Hainan Island[11,13,16] (Hoihow, Cheung-kon, Tai-pin, Nam-liu-tin, Kachek, Nodoa, Dome Mountain, Nam-fung, Lung-tong, Ch'ung-mei, Ta-hau, Liamui, Ta-han, Kau-sha, Sam-kwong, Lin-fa-ling); Pescadores Islands[15]; Formosa[7,10]

(Kankau, Anping, Taihorin, Hozan, Taihoku and other localities at low or medium altitudes). Year-round at Canton.

Distribution: South Kyushu[10]; Ryukyu Islands (Yakushima; Amami-Oshima; Miyako Island; Ishigaki Island; Iriomote Island[8]); Taiwan; Philippine Islands[6]; South China; Indo-China[4]; India[2]; Ceylon; East Indies[1,3,5].

Maulik's record of *C. catenata* Boheman from China is placed here. Maulik (1919, p. 406) indicated that "*catenata*" is probably only a variety of "*circumdata.*"

Cassida (Taiwania) discalis Gressitt

(Plate 30, figure 4)

Cassida discale Gressitt, 1938, Lingnan Sc. Jl., 17:386[1], 587[2]. (Type in C.A.S.)

Dorsal surfaces with explanate margins pale testaceous and discs largely black or pitchy; pronotum pitchy reddish to blackish on basal two-thirds of disc, a small pale spot near center of basal margin; each elytral disc with two or three small pale dots forming an oblique band near top of posterior declivity and extreme apex of disc pale; ventral surfaces pale with thoracic sterna and intercoxal process of first abdominal segment pitchy black; antennae pale with distal segment dusky; legs pale.

Dorsal outline oblong-oval; body feebly convex, barely more than one-fourth as deep as broad. Pronotum transversely elliptical, nearly two and one-half times as broad as long, not quite as broad as elytra; disc even, feebly punctured; explanate margins smooth, broadly rounded laterally. Elytra slightly narrowed at humeral angles, feebly raised at suture behind scutellum; disc of each with ten regular rows of punctures; second interspace (third anteriorly) raised and crossed by a sinuous subtransverse low ridge from swelling on suture to median line of disc; explanate margins fully one-half as broad at middle as discs, declivitous at an angle of about 33 degrees. Antennae gradually thickened toward apices, reaching to humeral angles of elytra. Length 5 mm.; breadth 4.2–4.55 mm.

China: Kiangsi (Hong Shan[1]); Kwangtung (Loh-fau-Shan[2]). At altitudes of about 1,000 meters. June; October.

Distribution: Southeast China.

Cassida (Taiwania) eoa (Spaeth)

Metriona eoa Spaeth, 1928, Sbornik Ent. Odd. Mus. Praha, 6:46[1]. (Type in Prague Museum.)

Cassida eoa, Spaeth, 1938, Ent. Tidskr., 59:255[2]

Shiny; brownish yellow; elytral tubercles with a common pitchy black spot and a pitchy brown area on first and second interpunctural rows behind middle on each elytron, or with tubercle reddish brown and each elytron with an oblique brown stripe from humerus to suture behind middle; explanate margin of each elytron with a narrow oblique basal spot separated from basal margin by a pale border nearly as wide as spot.

Form strongly triangular in dorsal outline; body broadest immediately behind humeri; moderately convex. Pronotum elliptical, more convex posteriorly; lateral angles rounded, placed before middle; disc feebly swollen, smooth. Elytra nearly twice as broad as prothorax; pronotal angles reaching end of first third of anterior border of explanate margin; humeri prominent, subacute; basal triangle of disc feebly impressed, followed by a low tubercle; lateral profile emarginate before and behind tubercle, less so behind; puncture-rows regular, deep and coarse, no finer posteriorly; interspaces narrow; a transverse ridge from tubercle to fourth interspace. Tarsal claws large. Length 6.5 mm.; breadth 5.5 mm.

China: Yunnan[1].

Distribution: Southwestern China; Burma[2].

Cassida (Taiwania) expansa Gressitt, new species

Dorsal surfaces greenish yellow to pitchy brown; pronotum pale yellowish, fairly transparent, marked on basal portion of disc with two anteriorly subdivergent pitchy-brown lines, each with a branch at apex diverging at a right angle, and basal margin of disc narrowly black; elytra each with explanate margin transparent hyaline and disc reddish brown with outer two interpunctural areas, four or five irregular spots along middle or near suture, as well as a large, transverse, common, X-shaped raised mark across summit, pale yellow with a greenish tinge, undoubtedly brilliant golden green in life; ventral surfaces, antennae and legs entirely pale testaceous.

Body almost perfectly circular in dorsal outline, narrowly emarginate between pronotum and humeri, moderately convex, barely one-third as deep as broad. Head with frontocplypeal area trapeziform, smooth, slightly convex, medially grooved. Antennae slender, hardly thickened distally, reaching well beyond humeral angles; third segment barely as long as fourth. Pronotum not quite twice as broad as long, narrowed and rounded-acute slightly anterior to middle of each side; disc distinctly convex, very feebly punctulate. Elytra with humeri slightly broader than pronotum, much narrower than widest portion, which is at middle of body; explanate margins impunctate, practically three-fourths as wide as discs at widest point; discs with a transverse, raised X-shaped mark across summit and a transverse, raised area at middle of lateral portion of each, partly seriate-punctate, punctures nearly as wide as interpunctural areas at middle, smaller elsewhere, lacking on all raised or pale areas except lateral borders, very few punctures on apical quarter. Ventral surfaces finely punctured. Tarsal claws broadly toothed basally. Length 6.7 mm.; breadth 6.6 mm.

Holotype (Lingnan Natural History Museum), **Sam-kwong-ts'uen, Lam-wan-tung, Kiung-shan District, central Hainan Island,** altitude 300 meters, August 5–6, 1935, F. K. To.

Differs from *C. versicolor* Boheman in being broader, more perfectly circular in dorsal outline and relatively less strongly convex, with the pronotal disc more evenly convex and the explanate margins of the elytra much more than one-half as wide as the discs.

Distribution: Hainan Island.

Cassida (Taiwania) expressa (Spaeth), new combination

Metriona expressa SPAETH, 1914, Ent. Mitt., 3:230[1]. (Type in Spaeth collection, Manchester.)

Dorsal surfaces brilliant yellow; green in life; green color retained in dried specimens to greater or lesser degree: covering entire disc or only along a stripe parallel to suture and an area on center of disc; ventral surfaces black; abdomen narrowly bordered with yellow; head and legs yellow; antennae yellow with apices slightly darkened.

Subquadrate, feebly narrowed posteriorly; strongly convex; shiny. Prothorax smooth, transversely elliptical, twice as broad as long, with lateral angles broadly rounded and located at middle of sides. Elytra about one-fourth broader than prothorax and more than twice as long; humeri rounded, moderately prominent; sides broadest anterior to middle, weakly narrowed posteriorly; discs distinctly concave in basal triangle; profile slightly concave anterior to raised portion of suture, declivitous posteriorly; puncture-rows coarse and regular, as broad as interspaces, second interspace slightly broader and higher than others, with a transverse ridge connecting with tubercle on suture; explanate margins strongly declivitous, finely rugulose-punctate. Tarsal claws with large teeth. Length 5.2–5.8 mm.; breadth 4.2–4.8 mm.

Some (Lingnan & C.A.S.) questionably this species, Suisapa, Lichuan, August 19, 1948, Gressitt, *et al.*

China: Yunnan[1]; Hupeh (Lichuan).

Distribution: Southwestern China.

Cassida (Taiwania) imitatrix Gressitt, new species

(Plate 30, figure 5)

Dorsal surfaces pale hyaline to ochraceous, marked in part with black: pronotum with explanate margin subtransparent, hyaline yellow, and disc pale ochraceous, feebly marked with a short pitchy sublongitudinal line on each side of center and a minute pitchy spot near middle of each side of disc; elytra with explanate margins similar to that of pronotum and discs translucent yellowish testaceous, marked with a narrow common spot at summit, an irregular, somewhat zig-zag mark extending from extreme base to apical third, crossing humeral callus and for most part external to median line of disc, as well as a few small scattered spots near scutellum, at middle and before apex, of black; ventral surfaces, legs and antennae testaceous, latter slightly darkened in distal quarter.

Body broadly rounded ovate in dorsal outline, broadest at end of basal third of elytra, somewhat narrowed posteriorly, evenly convex in transverse outline, not quite one-third as deep as broad, fairly even in lateral outline, a little more strongly declivitous posteriorly. Head with frontoclypeal area narrowly trapeziform, about twice as long as width at middle, not distinctly punctured. Antennae extending slightly beyond humeral angles, moderately and gradually thickened to end of basal third of last segment; third segment slightly longer than fourth or fifth. Pronotum fully twice as broad as long, transversely elliptical, rounded-subacute at lateral angles which are at middle of sides, symmetrical transversely except for a brief truncate projection at middle of basal margin; disc moderately convex, somewhat lobed above head, distinctly punctured on central portion. Scutellum subequilaterally triangular. Elytra with humeri rounded-subacute, projecting slightly beyond lateral angles of pronotum; explanate margins shallowly punctured, moderately declivitous, irregular along inner margins, fully one-half as wide as discs; suture moderately raised behind scutellum; disc of each with a transverse ridge from summit of suture to second interpunctural area where it branches obliquely anteriorly and posteriorly, with nine subregular rows of deeply impressed punctures, for most part as wide or wider than interpunctural areas and interrupted by forked swelling of summit. Ventral surfaces partially punctulate. Tarsal claws strongly toothed basally. Length 4.75 mm.; breadth 4.2 mm.

Holotype (Lingnan Natural History Museum), from mountains **five miles south of Lung-chow, Lung-chou District, Kwangsi Province, South China,** August 8, 1934, E. R. Tinkham.

Differs from *C. circumdata* Herbst in having the elytral explanate margins punctured and much less steeply declivitous, the elytral discs less evenly convex and the pronotal disc distinctly punctured. Differs from *C. obtusata* Boheman in having the elytral explanate margins fully one-half as wide as discs and the dorsum marked with black.

Distribution: South China.

Cassida (Taiwania) insulana Gressitt, new species

(Plate 30, figure 6)

Dorsal surfaces ochraceous marked with black: Pronotum entirely pale, ochraceous on disc and pale ochraceous hyaline on explanate margin; elytra with explanate margins similar to that of pronotum and discs black, each with a small spot at apex of scutellum, a large irregular area from base near scutellum to suture behind dorsal tubercle, an irregular spot at top of posterior declivity, and outermost interpunctural area, with an inward projection at middle of side and another at middle of apex, ochraceous; ventral surfaces testaceous, transparent; legs and antennae testaceous, latter very slightly darkened distally.

Body broadly rounded oval in dorsal outline, broadest very slightly anterior to middle, strongly convex, more than one-third as deep as broad; lateral outline rounded posteriorly, nearly straight from summit to anterior border of pronotum. Head with frontoclypeal area trapeziform, longer than broad, feebly punctured and slightly convex. Antennae just reaching to humeral angles or very slightly beyond, moderately and gradually thickened distally; third segment about as long as fourth. Pronotum slightly more than twice as broad as long, broadly rounded at middle of each side, evenly convex anteriorly and subtruncate posteriorly; disc subevenly convex, feebly punctured. Elytra with humeri rounded-subacute, slightly broader than pronotum; explanate margins slightly uneven; suggesting obsolete punctures, about one-half as wide as discs at middle; suture strongly raised behind scutellum; discs each with a transverse ridge from summit to second interpunctural area, continuing a short distance anteriorly and posteriorly as a feeble ridge, and ten rows of deep punctures, narrower than interpunctural areas near suture and outer margin, fully as wide in center. Ventral surfaces in part finely punctured. Tarsal claws distinctly toothed basally. Length 5.6 mm; breadth 4.75 mm.

Holotype (California Academy of Sciences), **Chirifu,** altitude 1,200 meters, **southeast of Rokki** (Rokkiri, Lakuli), **Kizan County, Kaoshiang** (Takao) **District, southwestern Taiwan,** May 19, 1934, Gressitt.

Differs from *C. versicolor* (Boheman) in having the pronotum punctured and more evenly convex, the elytral explanate margins shallowly punctured and the summit of the elytra not forming a raised X-shaped area. Differs from *C. imitatrix* Gressitt in having the pronotum broadly rounded at each side and the humeri declivitous and extending below sides of pronotum and each elytron with deep punctures along division between disc and explanate margin.

Another specimen, from Kosempo, Formosa, J. C. Thompson, in C.A.S. is not designated a paratype because the pronotum is more nearly plane, with lateral angles behind middle, the dorsal tubercle is more abrupt, and the tenth puncture-row is incomplete.

Distribution: Taiwan.

Cassida (Taiwania) juglans Gressitt

Cassida juglans GRESSITT, 1942, Lingnan Nat. Hist. Surv. & Mus. Spec. Publ., 5:4, fig. 4[1]. (Type in Musée Heude.)

Dorsum pale testaceous, somewhat ochraceous on scutellum, basal margins of prothorax and elytra, elytral suture and sides of elytral discs; antennae testaceous with last four segments slightly pitchy; ventral surfaces black with outer borders of abdomen testaceous; legs pale brownish testaceous with coxae, trochanters, and extreme bases of femora blackish.

Broadly oval, strongly convex and irregular. Head feebly punctured distally. Prothorax nearly three-fifths as long as broad, evenly rounded anteriorly, obtusely rounded laterally and somewhat sinuate posteriorly; disc evenly convex, distinctly though finely punctured; explanate margins not distinctly punctured; scutellum subequilateral, impunctate. Elytra slightly broader than prothorax at base, widened toward middle, strongly convex; suture distinctly raised; disc subregularly and rather finely punctured, highest portion with a short low transverse ridge connecting suture with an externally open low arcuate ridge; explanate margins strongly declivitous anteriorly, less so posteriorly, distinctly punctured, anteriorly with a few swellings extending from disc; ventral surfaces minutely punctured. Length 4.8–5 mm.; breadth 3.95 mm.

China: Chekiang (Mokan Shan[1]).

Distribution: Eastern China.

Cassida (Taiwania) juno Boheman

Cassida juno BOHEMAN, 1862, Mon. Cassid., 5:324[1]. (Type in Stockholm Museum ?.)

Dorsal surfaces entirely yellowish, shiny, with elytral punctures brownish; ventral surfaces testaceous with metasternum black and four basal abdominal segments each with a transverse pitchy black band; four distal antennal segments slightly darkened.

Body subrounded in dorsal outline, strongly convex. Head finely and closely punctured; pronotum broader than long, rounded anteriorly, basal margin sinuate on each side and with median lobe rounded-emarginate; lateral angles obtuse; disc convex, minutely punctulate; explanate margins broad, subtransparent. Elytra slightly broader than, and twice as long as, pronotum; humeri subangulate, moderately prominent, narrower than elytra in middle; discs seriate-punctate, punctures widely and irregularly spaced, surfaces depressed near scutellum, feebly swollen on suture behind scutellum; explanate margins moderately broad, obliquely deflexed, subhyaline, obsoletely punctured. Length 4.5 mm.; breadth 4 mm.

China: Hong Kong[1].

Distribution: South China.

Cassida (Taiwania) obtusata Boheman

(Plate 34)

Cassida obtusata Boheman, 1864, Mon. Cassid., 2:405[1]; Spaeth, 1914, Suppl. Ent., 3:19[2]; Maulik, 1919, Fauna Brit. Ind., Hisp. & Cass.: 376[3]; Chujo, 1934, Sylvia, 5:173[4]; Gressitt, 1938, Lingnan Sc. Jl., 17:192[5], 387[6], 588[7]; 1939, Pan-Pac. Ent., 15:142[8]. (Type in Stockholm Museum.)

Biology: Kershaw & Muir, 1907, Trans. Ent. Soc. London, 1907:251[9].

Brilliant golden in life; dried specimens with dorsal surfaces pale yellowish testaceous, with a slightly dirty brown appearance; explanate margins and much of elytral discs fairly transparent; pronotal disc and outermost interpunctural areas of each elytral disc partly opaque or translucent and yellowish brown; sometimes with a tinge of greenish near scutellum; ventral surfaces partly pitchy black on metasternum and abdominal sternites, testaceous on remainder and legs; antennae testaceous with last three segments partly pitchy.

Small, short, broadly rounded-ovate, narrowed posteriorly; moderately convex. Pronotum about twice as broad as long, subregularly elliptical; lateral angles obtuse and rounded; disc gradually declivitous and shallowly punctured. Elytra slightly raised at suture behind scutellum, otherwise fairly even and regularly punctured in ten rows. Length 3.7–5 mm.; breadth 2.8–4 mm.

Some (Lingnan) Chungan, Wingan, Maa; New Territories, Hong Kong, 1940–1941, Gressitt; (A.M.N.H.) Yen-ping, Spring, 1915, H. Caldwell.

Hosts: *Celosia argentea* Linn., *Amaranthus* spp. Adults also feed on *Citrus* spp[9].

China: Fukien (Chungan, Wingan, Yen-ping); Kwangtung[5,7] (Yim-na Shan, Canton, Hoppo, Ng-ch'uen, Kwang-chau-wan, On-po, Chung Shan, Meu-ming); Macao[9]; Hong Kong[8]; Hainan (Kainan) Island[6,7] (Dome Mt., Nodoa, Hoihow, Kachek, Five Finger Mts., Ngai-chau, Nam-fung, Loh-fung-tung, Cheung-kon); Taiwan[2,4] (Tainan, Shinkwa). Year-round at Canton.

Distribution: South China; Taiwan; Indo-China[2]; Burma[3]; India[1,3]; Luzon[2].

Cassida (Taiwania) plausibilis (Boheman), new combination

(Plate 28, figure 4)

Coptocycla plausibilis Boheman, 1862, Mon. Cassid., 4:395[1]; Baly, 1863, Jl. Ent., 1:14[2]. (Type in Stockholm Museum.)

Metriona plausibilis, Spaeth, 1914, Col. Cat., 62:144.

Metriona sp. Gressitt, 1938, Lingnan Sc. Jl., 17:191[3].

Metriona objecta, Gressitt (*not* Spaeth ?), 1938, t. c.: 584[4].

Testaceous yellow; part of basal margin of pronotum narrowly black; elytra marked with black spots on disc of each; three in a longitudinal row parallel to suture, five in a median row, the last, and largest, behind humeral callus; spots sometimes reduced to three or four, along suture and base.

Subrounded in outline; strongly convex. Prothorax one-half again as broad as long, broadly rounded anteriorly, smooth and shiny. Elytra nearly one-half again as broad as prothorax; humeri moderately prominent, subacute; discs depressed along suture and near scutellum, subrugose basally, deeply and closely seriate-punctate with interstices convex. Ventral surfaces punctured. Length 6 mm.; breadth 5.5 mm.

China: China[1]; Hainan Island[3,4] (Ta-hian, Ta-hau, Dome Mt., Hau-ying-ts'uen, Ch'ung-mei, Nam-fung, Lin-fa Shan, Fan-ta, Cheung-kon, Tai-tsing-tsing-lam).

Distribution: South China; Cambodia[2]; Hainan; Thailand[2].

From comparing these specimens from Hainan with the original descriptions of "*plausibilis*" and "*objecta,*" the writer is inclined to the opinion that the latter may be a subspecies or synonym of the former.

Cassida (Taiwania) purpuricollis (Spaeth), new combination

Metriona purpuricollis Spaeth, 1914, Ent. Mitt., 3:229[1]. (Type in Spaeth collection.)

Dorsal surfaces yellow; pronotal disc and scutellum purplish red; scutellum bordered with black; elytra bordered with black basally and on suture at apices, with five black spots: one on each humeral callus, a common one on suture behind scutellum and one on each explanate margin well behind middle; ventral surfaces black with border of abdomen very narrowly pale; legs yellow with bases of femora black; head reddish yellow; antennae yellow basally, brownish on fifth and sixth segments and remainder black.

Subtriangular, widest just behind humeri, slightly narrowed posteriorly; convex; shiny; glabrous. Prothorax small, transversely elliptical, twice as broad as long, with lateral angles broadly rounded, located at middle of sides; disc and margins smooth. Elytra twice as broad basally as prothorax; humeri subacute, strongly projecting at sides and reaching forward to a line through middle of prothorax; discs moderately convex, each with ten regular puncture-rows, the interspaces two to three times as broad as puncture-rows, feebly swollen and smooth; explanate margins very indistinctly rugulose-punctate, nearly smooth, strongly narrowed posteriorly. Prosternum fairly narrow between anterior coxae, its process angulately broadened, transversely triangular. Tarsal claws with large right-angled teeth, reaching beyond third tarsal segment. Length 7 mm.; breadth 5.5 mm.

One topotype (U.S.N.M.), identified by Spaeth.

China: Yunnan (Kunming[1]).

Distribution: Southwestern China.

Cassida (Taiwania) quadriramosa Gressitt, new species

Dorsal surfaces largely transparent reticulated with yellowish testaceous, marked with reddish brown; pronotum transparent, reticulate hyaline on explanate margins, slightly reddish yellow below disc; scutellum transparent, hyaline yellowish; elytra hyaline with discs reticulated with pale yellowish, marked with reddish brown at sides except at middle of lateral borders; explanate margins pale yellowish with humeri reddish brown and a squarish spot of same on posterolateral portion of each; ventral surfaces of body, as well as legs and antennae, testaceous.

Body with dorsal outline rounded-pentagonal, slightly longer than broad, nearly three-eighths as deep as wide. Head fully as broad as long; eyes large, broader than frontoclypeal area, which latter is subtriangular, slightly raised and nearly impunctate. Antennae slender in basal half, thickened and hairy distally, reaching beyond humeral angles by about three segments; third segment one-half again as long as second, subequal to fourth and fifth, separately. Pronotum practically twice as broad as long, evenly convex anteriorly, sinuate basally; lateral angles somewhat broadly rounded, placed at about middle, in longitudinal sense; disc smooth, impunctate; explanate margin slightly raised above head. Scutellum scutiform. Elytra barely broader than long; suture with a low, rounded-obtuse tubercle behind scutellum; disc of each with ten rows of fairly deep and regular punctures, each about as wide as spaces between them; humeri rounded, narrower than elytra at middle, and about one-fifth broader than pronotum; explanate margins at middle more than one-half as wide as discs, fully twice as wide as margins at apices. Tarsal claws toothed basally. Length 4.6 mm.; breadth 4.3 mm.

Holotype (Museum of Comparative Zoology) **Chang-yang,** altitude 4–6,000 feet, **near Ichang, Hupeh Province, central China,** July 1887, A. E. Pratt.

Differs from *C. rati* Maulik in being smaller, less strongly convex, more rectangular and paler, with the pronotum not fully twice as broad as long, the elytra less strongly tuberculate at summit, with punctures much larger, as wide as interspaces, and discs not distinctly swollen at middle of each side, and the suture not distinctly pigmented at apex.

Distribution: Central China.

Cassida (Taiwania) rati Maulik

Cassida rati MAULIK, 1923, Proc. Zool. Soc. London, 1923:605, text-fig. 6[1]; SPAETH, 1938, Entom. Tidskr., 59:236[2]. (Type in British Museum.)

Metriona rati, SPAETH, 1928, Sbornik Ent. Odd. Nar. Mus. Praze, 6:46.

Moderately convex, broad and subtriangular in outline. Reddish ochraceous; explanate margins amber-yellow except for a dark pitchy red spot on each at humerus and another similar one somewhat behind middle; suture also darkened at apices and sides of disc darkened in an arcuate band which connects dark patches of explanate margins; antennae with last four segments pitchy black; ventral surfaces black with pleura and coxae largely ochraceous; legs ochraceous.

Frons with a swelling near antennal insertions; antennae reaching to slightly beyond humeral angles of elytra, fairly slender, hardly thickened apically, with third segment twice as long as second; prothorax much narrower than elytra at humeri, fairly evenly convex anteriorly and laterally, slightly produced at middle of base, even and impunctate on disc; scutellum triangular, impunctate; elytra broadest at humeri, which are prominent and subrounded, rather strongly raised on suture behind scutellum, regularly and moderately punctured on discs, impunctate and smooth on the moderately declivitous explanate margins except for a ridge extending to border from disc just behind humerus and some similar ones near apex. Length 6.7–7 mm.; breadth 5.6–6 mm.

Several (C.A.S. & Lingnan) Shaowu, Kien-yang, April-August, Maa; Hong Shan, altitude 1,000 meters, June 1936, Gressitt.

China: Chekiang (Hangchow[2]); Kiangsi (Hong Shan); Fukien (Shaowu, Kien-yang); Taiwan (Arisan[2]).

Distribution: Manipur[1]; Burma[2]; South China; Taiwan[2].

Cassida (Taiwania) sauteri Spaeth

Taiwania sauteri SPAETH, 1913, Ann. Mus. Nat. Hung., 11:481[1]; 1914, Suppl. Ent., 3:17[2]; CHUJO, 1934, Sylvia, 5:168[3]. (Type in Budapest Museum (?).)

Taiwania achardi SPAETH, 1928, Sbornik Ent. Odd. Nar. Mus. Praze, 4:93[4].

Cassida sauteri, SPAETH, 1938, Ent. Tidskr., 59:236.

Color testaceous amber; pronotal and elytral discs deep reddish ochraceous, darker on sides of elytral discs, nearly black along sides above inner borders of explanate margins; antennae, legs and ventral surfaces reddish ochraceous.

Moderately large, broadly ovate. Frons impunctate, slightly convex; antennae not quite reaching to humeral angles of elytra, slightly thickened beyond middle, black at extreme tip; prothorax distinctly narrower than elytra at humeri, nearly twice as broad as long, evenly rounded anteriorly and laterally, sinuate basally with a truncate process meeting scutellum; pronotal disc even and impunctate; scutellum triangular, impunctate; elytra broadest at about middle, with humeri prominent but rounded, suture raised behind scutellum, discs moderately punctured in regular rows and depressed anteriorly and externally to raised area on suture; explanate margins fairly declivitous, impunctate. Length 7–7.4 mm.; breadth 5.6–6 mm.

One (A.M.N.H.) Yen-ping, July 18, 1917, Harry Caldwell; one (C.A.S.) Urai, Formosa, June 26, 1932, Gressitt.

China: Fukien (Yen-ping); Taiwan[1,2,3] (many localities, mostly 300–2,000 meters in altitude).

Distribution: Taiwan; South China; Tonkin[4].

Cassida (Taiwania) sigillata (Gorham), new combination

Coptocycla sigillata GORHAM, 1885, Proc. Zool. Soc. London, 1885:284[1]; SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (131); 1914, Col. Cat., 62:130. (Type in British Museum.)

Metriona sigillata, SPAETH, 1926, Best.-Tab. Eur. Col., 95:66; CHUJO, 1934, Sylvia, 5:158; GRESSITT, 1939, Pan-Pac. Ent., 15:141[2].

Dorsal surfaces dark pitchy red-brown on pronotal and elytral discs and basal portion of explanate margin of each elytron; remainder of explanate margins hyaline, fairly transparent; outermost interpunctural area of each elytral disc yellowish; ventral surfaces black except for most of thoracic pleura and abdominal borders, which are testaceous, as are head, antennae and legs; coxae partly pale.

Body rounded-triangular in outline, broadest just behind humeri and not very strongly narrowed posteriorly; moderately convex. Pronotum nearly twice as broad as long, transversely elliptical with rounded angles at middle of each side; disc even and impunctate, slightly depressed on extreme base at each side of middle. Elytra distinctly broader than prothorax; humeri prominent and rounded; disc of each rather irregular, with ten rows of fine punctures, but with the rows interrupted by four major subtransverse sinuate ridges and some lesser swellings; explanate margins raised and coarsely punctured at humeri, narrowed posteriorly. Length 5.9 mm.; breadth 5.1 mm.

Some (Lingnan) Shaowu, April-May, Maa; Loh-chang, August, Tsang & Lam; (C.A.S.) Taiheizan, June, 1934, Gressitt; Arisan, March, 1935, Miwa.

China: Chekiang (Mokan Shan[2]); Fukien (Shaowu); Kwangtung (Loh-chang); Formosa (Taiheizan, Arisan). March to September.

Distribution: Japan[1] (Honshu); eastern China; Taiwan.

In the Taiwan specimen the elytral punctures are twice as large as in typical specimens, and there are almost twice as many per row. The specimen is otherwise typical.

Cassida (Taiwania) spaethiana Gressitt

(Plate 28, figure 5)

Taiwania spaethi GRESSITT (*not* Weise, 1900), 1942, Lingnan Nat. Hist. Surv. & Mus. Spec. Publ., 5:2, fig. 2[1]. (Type in Lingnan Museum.)

Cassida spaethiana GRESSITT, 1945, Lingnan Sc. Jl., 21:147 (n. n.).

Dull ochraceous to testaceous brown with some indistinct pitchy markings; explanate margins of prothorax and elytra transparent, pale golden amber, finely reticulate; head ochraceous; antennae ochraceous, pale reddish brown on distal segments; pronotal disc pale ochraceous, subtransparent; scutellum pale ochraceous, pitchy red along borders, as are basal margins of pronotum and elytra; elytral discs largely reddish or yellowish ochraceous, each paler to testaceous amber on inner three-fifths of basal half and yellowish testaceous along outermost interpunctural stripe, and on next to outermost at extreme base, middle of side and apical margin of disc, nearly pitchy to subtestaceous on inner portions of posterior half; ventral surfaces of body largely dirty ochraceous, partly transparent; legs orange ochraceous.

Frons trapeziform, impunctate; antennae reaching slightly beyond humeral angles, slender, feebly thickened and subacute distally; prothorax not quite twice as broad as long, symmetrical except for posterior median process, broadly rounded at sides; scutellum triangular, rounded posteriorly; elytra distinctly broader than prothorax, humeri projecting, explanate margins broad and moderately declivitous; disc of each with ten rows of fairly small punctures, a transverse swelling at suture behind scutellum and a concave area anterior to and external to this, fifth and sixth puncture-rows more deeply concave behind middle. Length 6.85 mm.; breadth 5.65 mm.

China: Northern Kwangtung (Lien-ping District[1]).

Distribution: South China.

Cassida (Taiwania) versicolor (Boheman)

(Plate 28, figure 6)

Coptocycla versicolor BOHEMAN, 1855, Mon. Cassid., 3:414[1]. (Type in Stockholm Museum.)

Coptocyla Thais BOHEMAN, 1862, Mon. Cassid., 4:463[2]; BALY, 1874, Trans. Ent. Soc. London, 1874:214[3]; KRAATZ, 1879, Deutsche Ent. Zeits., 23:271; GORHAM, 1885, Proc. Zool. Soc. London, 1885:284; SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 65 (Sitzb.): (130)[4].

Coptocycla crucifera KRAATZ, 1879, Deutsche Ent. Zeits., 23:271[5]; GORHAM, 1885, Proc. Zool. Soc. London, 1885:283.

Metriona Thais, SPAETH, 1914, Col. Cat., 62:144; 1926, Best.-Tab. Eur. Col., 95:65[6]; YUASA, 1932, Nippon Konchu Zukan: 582[7], fig. 1143; CHUJO, 1934, Sylvia, 5:160; GRESSITT, 1938, Lingnan Sc. Jl., 17:585[8]; 1939, Pan-Pac. Ent., 15:141[9].

Metriona versicolor, SPAETH, 1914, Col. Cat., 62:144.

Metriona thais crucifera, SPAETH, 1914, l. c.; CHUJO, 1934, Sylvia, 5:160[10]; GRESSITT, 1938, Lingnan Sc. Jl., 17:191[11], 586[12].

Thlaspida chinensis, GRESSITT (*not* Spaeth), 1938, t. c.: 17:385[13].

Cassida versicolor ab. *crucifera*, SPAETH, 1938, Ent. Tidskr., 59:235[14].

Dorsal surfaces variable in color; pronotal disc generally dark on central swollen area, pale on lateral lobes, often with a pair of pale stripes near base; elytral discs with swollen areas, anterior portions of lateral borders, and some spots behind middle, pale, darkest on sublateral portions; each explanate margin with or without a pitchy oblique mark at posterolateral angle; ventral surfaces, legs and antennae testaceous, latter with distal segments sometimes darkened.

Dorsal outline subcircular, broadest at middle. Pronotum not quite as broad as long, more strongly convex basally than apically; sides rounded-angulate, angles slightly anterior to middle in longitudinal sense; disc impunctate, with central and lateral swollen lobes. Elytra with humeri subangulate, feebly projecting; discs transversely raised across suture behind scutellum, raised area branching obliquely forward and backward at each side; another transverse raised area on each at middle of side; surfaces deeply seriate-punctate, rows interrupted by raised areas. Length 5.3–6.2 mm.; breadth 4.8–5.3 mm.

Some (Lingnan) Shaowu, Chungan, Chang-ting, Bohea Hills, April-May, Fukien, Maa; Suisapa, Lichuan, July-August, 1948; (C.A.S.) Iriomote Island, Ryukyu Islands, August 20; Hassenzan, Taiwan, June 26, 1934, Gressitt; (Taiwan Agriculture Research Institute) Shuri, Okinawa, April, 1941, Matsuda.

Hosts: *Pyrus serotina* Rehder, *Malus* sp., *Sorbus gracilis* K. Koch, *Prunus* sp[7].

China: "N. China"[2]; Hupeh (Lichuan); Chekiang[9] (Mokan Shan, Hangchow); Kiangsi[13] (Hong Shan, Tai-au-hong, Kuling); Hunan[8] (Lammo); Fukien[13] (Shanghang, Shaowu, etc.); Kwangtung[13] (Tai-yong, Yao Shan, Lung-ping-hui); Hainan[11,12] (Nodoa, Tai-pin, Kom-yan); Taiwan[6,10] (northern part).

Distribution: Amur[4]; Japan[3,5]; Ryukyu Islands; Taiwan; China[1]; Hainan; Tonkin[6]; Burma[14].

Subgenus **Mionycha** Weise

Mionycha WEISE, 1891, Wien. Ent. Ztg., 10:204; 1893, Ins. Deutschl., 6:1075; SPAETH, 1926, Best.-Tab. Eur. Col., 95:24; CHUJO, 1934, Sylvia, 5:167.

Dorsal outline of body ovate or rounded; body fairly convex. Head black; central portion of clypeofrontal area forming a narrow triangle terminating in a longitudinal groove. Elytra with regular longitudinal rows of punctures. Tarsal claws not toothed, closely approximate, short, hidden in hairs of third tarsal segment.

Subgenerotype: *Cassida azurea* Fabricius (Europe).

Range: Palearctic region.

Cassida (Mionycha) concha Solsky

Cassida concha Solsky, 1872, Horae Soc. Ent. Ross., 8:264[1]; Kraatz, 1879, Deutsche Ent. Zeits., 23:269. (Type in Moscow Museum.)

Cassida (Mionycha) concha Weise, 1893, Ins. Deutschl., 6:1090; Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (129[2]); 1914, Col. Cat., 62:96[3]; 1926, Best.-Tab. Eur. Col., 95:51[4]; Chujo, 1934, Sylvia, 5:167.

Dorsal surfaces yellow, deeper yellow on outer two interpunctural areas of elytral discs; ventral surfaces black except for borders of abdominal segments; legs yellow; antennae yellow with apices slightly darkened.

Dorsal outline circular; body strongly convex, vertically declivitous posteriorly. Pronotum nearly twice as broad as long, impunctate; lateral angles briefly rounded-obtuse; located at middle in longtitudinal sense. Elytra slightly swollen at suture behind scutellum, a transverse swelling extending to second interpunctural area on each side; discs coarsely seriate-punctate; interpunctural areas narrow, last two wider; explanate margins with coarse, scattered punctures. Length 5 mm.; breadth 4 mm.

Distribution: Siberia[1] (Amur[2]; Ussuri[3,4]); Japan[4] (Honshu).

Subgenus **Cassida** Linnaeus, *sensu stricto*

Body oblong or elongate-oval in dorsal outline, rarely ovate, not very strongly convex. Frontoclypeal area trapeziform. Antennae short, rarely reaching beyond humeral angles, thickened distally. Pronotum transverse, generally broadest near base. Elytra subparallel-sided. Tarsal claws untoothed, not completely hidden.

Subgenerotype: *Cassida nebulosa* Linnaeus (Palearctic region).

Range: Largely Palearctic, extending into Oriental and Ethiopan regions.

KEY TO THE CHINESE SPECIES OF CASSIDA SENSU STRICTO

1. Elytra regularly seriate-punctate, without any punctures in central portion between third and fourth puncture-rows 2

— Elytra not regularly seriate-punctate throughout, at least with some extra punctures between third and fourth puncture-rows 7

2.(1) Explanate margins of elytra not distinctly thickened at borders in central portion 3

— Explanate margins of elytra strongly thickened at borders in central portion; dorsum yellowish brown with fine black speckling; pronotum broadly rounded at sides .... *C. nebulosa*

3.(2) Pronotum narrowly rounded or subacute at sides, not broadly rounded; lateral angles anterior to middle, or near base 4

— Pronotum broadly rounded at middle of each side; frontoclypeal area impressed with deep converging oblique grooves 5

4.(3) Lateral angles of pronotum rounded-angulate, located near base; elytral discs and explanate margins rather steeply declivitous at sides; venter generally pale .... *C. berolinensis*

— Lateral angles of pronotum subacute, placed slightly anterior to middle; elytral discs and explanate margins not steeply declivitous at sides; venter black .... *C. nucula*

5.(3) Head strongly narrowed anteriorly 6

— Head subtrapeziform; body evenly convex, with regular puncture-rows; humeral angle practically touching middle of side of pronotum .... *C. klapperichi*

6.(5) Explanate margins of elytra lacking black marking; body one-fourth again as long as broad; elytral discs generally reddish brown, sometimes with numerous longitudinal lines and spots of black .... *C. japana*

— Explanate margin of each elytron with a posterolateral black mark; body nearly one-half again as long as broad; elytral discs always partly black at sides .... *C. piperata*

7.(1) Head black; body only rarely as much as one-third as deep as broad 8

— Head reddish, coarsely punctured; body fully two-fifths as deep as broad; second interpunctural area of each elytron strongly raised; pronotum broadly rounded laterally, reddish; elytra red or black .... *C. pallidicollis*

8.(7) Dorsal surfaces contrastingly marked with distinct discal spots on elytra, including one on each humeral callus, or with pronotal and elytral discs largely black and explanate margins shiny yellow 9

— Dorsal surfaces not contrastingly marked in dried specimens, generally reddish yellow or greenish on explanate margins as well as discs 10

9.(8) Pronotal and elytral discs almost entirely black; humeral angles subacute; body less than one-third again as long as broad .... *C. probata*

— Dorsum reddish with suture and about six spots on each elytral disc black; humeral angles rounded; body fully one-half again as long as broad .... *C. lineola*

10.(8) Legs completely black; elytra with short bristle-like hairs; labrum broadly and shallowly emarginate apically; explanate margins sharp-edged 11

— Legs not entirely black, though femora sometimes black basally; explanate margins not very sharp-edged 15

11.(10) Frontoclypeal area fully as broad as long; body slightly more than one-third as deep as broad; lateral angles of pronotum distinctly angulate; elytral discs generally lacking transverse rugae 12

— Frontoclypeal area about one-fourth again as long as broad; body less than one-third as deep as broad; explanate margins subhorizontal; lateral margins of pronotum broadly rounded; elytral discs with several irregular subtransverse rugae; dorsum largely black or rusty brown................*C. mongolica*

12.(11) Prothorax narrower than elytral humeri; elytra subparallel-sided, not widened behind humeri.. 13

— Prothorax as broad as elytral humeri; elytra widened behind humeri; elytral punctures not very regular; discs clouded; explanate margins pale.. *C. laticollis*

13.(12) Pronotum strongly tapering and distinctly angulate at each side; frontoclypeal area as long as broad; anterior margin of humeral angle thickened and raised 14

— Pronotum moderately tapering, obtusely rounded at each lateral angle; frontoclypeal area broader than long; anterior margin of humeral angle not thickened and raised ....*C. sikanga*

14.(13) Elytra without a distinct tubercle behind scutellum, feebly concave near scutellum; pronotal angles behind middle; length of body about 6 mm.; breadth 4 mm..*C. fuscorufa*

— Elytra with a distinct tubercle behind scutellum, distinctly concave beside scutellum; pronotal angles near middle; length of body 7–8 mm.; breadth 5.5–6.5 mm. ....*C. jacobsoni*

15.(10) Interpunctural areas of elytral discs lacking minute hairs.......................... 16

— Interpunctural areas of elytral discs with minute white hairs; form elongate-oval; pronotum subsemicircular, closely meeting base of elytra; explanate margins of elytra less than one-third as wide as discs.........................*C. mandli*

16.(15) Frontoclypeal area distinctly longer than broad.. 17

— Frontoclypeal area fully as broad as long.. 18

17.(16) Explanate margins of elytra fully one-half as broad as discs at middle; pronotum as broad as elytra, evenly arcuate anteriorly..*C. rubiginosa rugosopunctata*

— Explanate margins of elytra barely one-third as broad as discs at middle; pronotum narrower than elytra, obtusely rounded-angulate anteriorly..*C. rubiginosa taiwana*

18.(16) Pronotum much narrower than elytra, with lateral margins rounded near middle of each side.. 19

— Pronotum as broad as elytra, or practically so, with lateral margins narrowed and subacute, the angles placed close to base; elytral discs subregularly punctured, with interpunctural areas slightly raised and for most part slightly broader than puncture-rows..*C. prasina*

19.(18) Humeral angles broadly rounded, a free space between them and lateral angles of pronotum; labrum broadly emarginate; length of body 7 mm.; breadth 5 mm. ....*C. spaethi*

— Humeral angles subacute, slightly produced, closely meeting basal margin of pronotum; labrum narrowly emarginate; length of body 6 mm.; breadth 4 mm. ....*C. stigmatica*

Cassida (s. str.) **berolinensis** Suffrian

Cassida obsoleta Herbst *(not* Illiger), 1799, Natursyst. Käf., 8:248, pl. 131, fig. 5.

Cassida berolinensis Suffrian, 1844, Stett. Ent. Ztg., 5:270[1]; Boheman, 1854, Mon. Cassid., 2:458; Kraatz, 1874, Berl. Ent. Zeits., 18:94; Weise, 1889, Horae Soc. Ent. Ross., 23:571[2]; Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (142)[3]. (Type in Stettin Museum (?).)

Cassida daurica Boheman, 1854, Mon. Cassid., 2:457[4].

Cassida berolinensis ab. *pallidiventris* Reitter, 1912, Fauna Germ., 4:215[5].

Cassida berolinensis ab. *pectoralis* Weise, 1896, Wien. Ent. Ztg., 15:81[6].

Cassida (Cassida) berolinensis, Spaeth, 1926, Best.-Tab. Eur. Col., 95:32[7].

Dorsal surfaces yellowish brown, sometimes with elytral suture black on basal quarter, three black spots on disc of each elytron and sutural angles black; ventral surfaces and antennae brownish to reddish, sometimes thoracic sterna and central portions of abdominal sterna black.

Briefly ovate. Pronotum broadest close to base, very slightly narrowed behind lateral angles, closely and finely punctured; explanate margins fairly declivitous, punctured on inner portions and with a row of punctures parallel to margin. Elytra strongly convex, with regular rows of deep punctures and no punctures in interspaces; second interspace wider than others, sides raised slightly; steeply declivitous. Length 3.5–5 mm.; breadth 2.5–4 mm.

China: Mongolia[2] (Ordos). September.

Distribution: Europe[1,3,5,6]; Mongolia; eastern Siberia[4,7].

Cassida (s. str.) **fuscorufa** Motschulsky

Cassida fuscorufa Motschulsky, 1866, Bull. Soc. Nat. Mosc., 39, 1:178[1]; Kraatz, 1879, Deutsche Ent. Zeits., 23:268, 273[2]; Gorham, 1885, Proc. Zool. Soc. London, 1885:282 *(fusco-rufa);* Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (138); 1926, Best.-Tab. Eur. Col., 95:36[3]; Yokoyama, 1931 (Col. Japan), 2:19, pl. 3, fig. 5; Chujo, 1934, Sylvia, 4:177[4]; 1938, Mushi, 11:168[5]; Gressitt, 1938, Lingnan Sc. Jl., 17:587[6]; 1939, Pan-Pac. Ent., 15:142[7]. (Type in Moscow Museum (?).) Spaeth, 1942, Arb. morphol. taxon. Ent. Berlin-Dahlem, 9:12 (Erzendjanzsy).

Cassida consociata Baly, 1874, Trans. Ent. Soc. London, 1874:213[8].

Cassida russata, Weise *(not* Fairmaire, 1887), 1889, Horae. Soc. Ent. Ross., 23:646.

Dorsal surfaces dull reddish brown, paler and slightly transparent on explanate margins; ventral surfaces black except for parts of pro- and mesothoracic pleura and borders of abdomen; antennae partly black on scape, red on next five segments and black on last five; legs black with tarsi partly reddish.

Dorsal outline oval, very slightly broader anteriorly than posteriorly; body about two-fifths as deep as wide. Head closely punctured. Antennae gradually thickened, not quite reaching humeri. Pronotum not quite twice as broad as long, obtusely angulate laterally, evenly arcuate anteriorly, sinuate basally, finely punctured on both disc and explanate margins. Elytra distinctly raised along suture, each with ten or twelve subregular rows of punctures, with second and fifth (fourth posteriorly) interspaces more strongly raised than others, and explanate margins irregularly punctured. Length 5.5–6.2 mm.; breadth 3.7–4.2 mm.

Some (Lingnan) Chang-ting, Shaowu, Pu-si, January-May, Maa; An-yuen, Djou.

China: Hopei (?) ("Oo Oo" Bay[8]); Shantung (Lao Shan[5]); Kiangsu (Nanking[7]); Kiangsi (Kuling[6], An-yuen); Chekiang (Hangchow[7]); Fukien (Chang-ting, Shaowu); Manchuria (Erzendjanzsy); Taiwan[4]. May-June.

Distribution: Eastern Siberia (Amur[2]); eastern China; Korea[3]; Taiwan; Japan[1].

Cassida (s. str.) **jacobsoni** Spaeth

(Plate 29, figure 5)

Cassida Jacobsoni SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (138)[1]. (Type in Spaeth collection.)

Cassida (Cassida) jacobsoni SPAETH, 1926, op. cit., 95:36.

Dorsal surfaces rust-red, elytral discs somewhat darker; ventral surfaces and legs black; antennae black with scape and apex of last segment reddish.

Head rugose, indistinctly punctured. Prothorax transversely subhexagonal; pronotal disc very coarsely, but shallowly punctured. Elytra broader basally than prothorax, humeri fairly prominent, rounded, sides slightly broadened to before middle, then narrowed, discs bluntly tuberculate behind scutellum and with large, shallow, seriate punctures, a deep basal groove between second and fifth puncture-rows, another posteriorly external to fourth interspace; interspaces with short, erect hairs. Length 7–8 mm.; breadth 6.5 mm.

Many (Lingnan) Shaowu, Chungan, Chang-ting, April-June, Maa; Kuatun, Klapperich; (Heude) Tien-mu Shan.

China: Fukien ("Kuatien"[1], Kuatun, Shaowu, etc.); Chekiang (Tien-mu).

Distribution: Southeast China.

Cassida (s. str.) **japana** Baly

(Plate 33)

Cassida japana BALY, 1874, Trans. Ent. Soc. London, 1874:212[1]; KRAATZ, 1879, Deutsche Ent. Zeits., 23:273; SPAETH, 1914, Col. Cat., 62:103[2]; 1914, Verh. Zool.-Bot. Ges. Wien, 64: (Sitzb.): (130); 1914, Suppl. Ent., 3:19[3];

1926, Best.-Tab. Eur. Col., 95:31[4]; Chujo, 1934, Sylvia, 5:174[5]; Gressitt, 1939, Pan-Pac. Ent., 15:142[6]; Spaeth, 1940, Kol. Rundschau, 26:37[7]. (Type in British Museum.)

Cassida rugifera Kraatz, 1879, Deutsche Ent. Zeits., 23:274[8].

Cassida piperata var. *japana*, Weise, 1900, Arch. f. Naturg., 66, 1:295.

Cassida lineola, Gressitt (*not* Creutzer), 1938, Lingnan Sc. Jl., 17:387[9], 587[10].

Dorsal surfaces entirely ochraceous brown, paler on explanate margins, or with elytra marked with many vaguely defined or coalescent spots or short longitudinal lines of black; ventral surfaces black; legs largely pale; antennae generally pale.

Dorsal outline rounded-oblong; body about one-third as deep as broad. Pronotum oval, about twice as broad as long, broadly rounded laterally; disc finely punctured; explanate margins slightly irregular. Elytra with suture moderately raised a short distance behind scutellum; disc of each regularly and closely punctured in about ten rows, second and fourth interspaces moderately raised, with a few transverse connectives; explanate margins about one-third as wide as discs, declivitous at an angle of about 40 degrees. Length 5–5.5 mm.; breadth 4–4.5 mm.

Many (Lingnan) Shaowu, Wingan, Chungan, Bohea Hills, April-June, Maa; Pe-pei, Lichuan, Lung-tau Shan, Loh-chang, July-August, Djou & Tsang; (Ac. Sin.) Bao-hwa Shan; (A.M.N.H.) Yen-ping, July, 1917, H. Caldwell; (M.C.Z.), Foochow, April, 1886, Leech; Chin-cheng Shan, July, 1932, G. Liu.

Host: *Alternanthera sessilis* R. Br. (Canton).

China: Szechuan[4] (Chin-cheng Shan, Pe-pei); Hupeh (Lichuan); Kiangsu (Shanghai[7]); Anhwei (Bao-hwa Shan); Chekiang (Tunglu, Mokan Shan[6]); Kiangsi (SE.[9]); Kwangtung (Yao Shan, Canton[10], Lung-tau Shan, Loh-chang); Fukien (Yen-ping, Shaowu, Wingan, Foochow, etc.); Taiwan[3,5] (mountains of northern and central part). Year round at Canton.

Distribution: Japan[8] (Kyushu[1,6]; Shikoku[5]; Honshu[6]); South China; Taiwan; Indo-China[2,4].

This species is intermediate between the subgenera *Cassida* and *Taiwania* in some respects, particularly as regards the body form, though the tarsal claws are not very distinctly toothed and the explanate margins are barely hyaline.

Cassida (s. str.) **klapperichi** Spaeth

(Plate 29, figure 3)

Cassida Klapperichi Spaeth, 1940, Koleopt. Rundschau, 26:37[1].

Strongly and evenly convex, evenly rounded-oval; entirely testaceous brown, very slightly darker on summit of elytra.

Frontoclypeal area trapeziform, subrounded apically. Pronotum broadly rounded at sides in male, almost angulate laterally in female, finely punctured on disc and explanate margin. Elytra evenly convex, broadened behind bases, rather regularly seriate-punctate, hardly depressed on basal triangle; humerus angulate, projecting forward, nearly touching margin of pronotum; explanate margin more finely and irregularly punctured. Length 5–6 mm.; breadth 3.75–4.25 mm.

Some (Lingnan) Pu-si, April, Maa; (Heude) Zikawei, June.

China: Kiangsu (Shanghai[1], Zikawei); Hunan (Pu-si).

Distribution: Eastern China.

Cassida (s. str.) **laticollis** Gressitt, new species

(Plate 30, figure 7)

Somewhat opaque pale brownish testaceous; pronotal and elytral discs in part irregularly pitchy brown; head pitchy black; antenna testaceous on first five segments, reddish on sixth and pitchy black on remainder; thoracic and abdominal sternites pitchy black, testaceous on lateral borders; legs pitchy black.

Head round; frontoclypeal area trapeziform, as broad as long, somewhat irregular, transversely raised near middle, not distinctly punctured. Antenna barely reaching to humerus, moderately thickened distally; second segment fairly large; third slightly longer than second; fourth subequal to second, more slender; fifth equal to fourth; sixth slightly shorter; seventh strongly thickened; eighth to tenth each about as broad as long; eleventh nearly twice as long as tenth, stout, tapering, not very acuminate. Prothorax more than twice as broad as long, somewhat unevenly obtusely rounded anteriorly, moderately angulate just behind middle of each side; disc gradually declivitous on each side from median raised area, flat or depressed at edges; disc in part irregularly and shallowly punctured or uneven; explanate margin more extensively, and likewise shallowly, punctured. Scutellum equilaterally triangular, slightly convex in center. Elytra no broader than prothorax at humeri, very slightly broadened towards middle of body, feebly narrowed posteriorly, broadly rounded apically, one-third as deep as broad; suture rather distinctly raised, particularly just behind scutellum; disc of each with about ten not very regular rows of punctures of varying sizes, mostly narrower than interspaces, which are in part slightly raised longitudinally, with a few oblique or transverse raised lines; basal triangle moderately concave posteriorly; a feeble depression on each side anterior to middle and a shallow longitudinal one external to fifth puncture-row; explanate margin somewhat steeply declivitous laterally, a little more flattened, but fairly narrow, posteriorly; humeral angle somewhat squarish, close to lateral angle of prothorax. Ventral surfaces rather feebly wrinkled or punctured. Length 6 mm.; breadth 4.4 mm.

Holotype, female (?) (California Academy of Sciences), **Suisapa,** altitude 1,000 meters, **Lichuan District, western Hupeh Province, West China,** July 24, 1948, Gressitt.

Differs from *C. jacobsoni* Spaeth in being narrower, with the explanate margins of elytra more declivitous, the prothorax more strongly convex and obtuse in outline of anterior margin, with the disc more uniformly punctured and smoother and more depressed at sides and the coloration different.

Cassida (s. str.) **lineola** Creutzer

(Plate 29, figure 6)

Cassida lineola Creutzer, 1799, Ent. Vers.: 119, pl. 2, fig. 23[1]; Suffrian, 1844, Stett. Ent. Ztg., 5:210; Boheman, 1854, Mon. Cassid., 2:450; Fairmaire, 1888, Revue d'Ent., 7:157[2]; Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (138); 1914, Col. Cat., 62:104[3]; 1926, Best.-Tab. Eur. Col., 95:34; Chujo, 1934, Sylvia, 5:175.

Cassida russica Herbst, 1799, Natursyst. Käf., 8:232, pl. 131, fig. 1 ♂[4].

Cassida signata Herbst, 1799, l. c.: 234, pl. 131, fig. 2 ♀[5].

Cassida sibirica Gebler, 1833, Bull. Soc. Nat. Mosc., 6:306[6]; Kraatz, 1874, Berl. Ent. Zeits., 18:97; 1879, Deutsche Ent. Zeits., 23:267.

Cassida bicostata Fischer, 1842, Cat. Col. Sib. Or. Karel.: 24 ♀[7].

Cassida suturalis Fischer, 1842, l. c. ♂ 8.

Cassida nigroguttata Gorham, 1885, Proc. Zool. Soc. London, 1885:281[9].

Cassida nigrostrigata Fairmaire, 1888, Revue d'Ent., 7:157[10].

Cassida lineola ab. *russica*, Spaeth, 1914, Col. Cat., 62:104.

Cassida lineola var. *sibirica*, Spaeth, 1914, l. c.

Cassida lineola ab. *nigrostrigata*, Spaeth, 1914, l. c.

Cassida lineola ab. *formosana* Chujo, 1934, Sylvia, 5:172, 176[11].

In life green with shiny silvery lines. Dried specimens: Dorsal surfaces bright red to reddish brown, marked with black; pronotum unicolorous, red or reddish brown; scutellum red or partly black; elytra black along suture and very narrowly along basal margins; disc of each with several bold elongate-oval black spots in two longitudinal lines, second starting with a spot on humeral callus, or with feeble blackish streaks; ventral surfaces and legs black or reddish brown.

Body oblong-oval in dorsal outline, rounded anteriorly and posteriorly, fully one-third as deep as broad. Pronotum fully twice as broad as long in male, not quite twice as broad as long in female, strongly rounded anteriorly, slightly sinuate basally; lateral angles obtuse, very close to base; surface entirely covered with dense punctures; elytra as broad as, or slightly broader than, pronotum, hardly raised on suture behind scutellum; disc of each deeply punctured in about 12 partly confluent rows; explanate margins about one-fifth as broad as discs, declivitous and shallowly punctured.

Antennae fairly stout, thicker distally, barely reaching humeral angles. Length 5.8–7.8 mm.; breadth 4.5–5.4 mm.

Several (M.C.Z.) Chang-yang, 1,500 meters, near Ichang, July, 1887, A. E. Pratt; Ping-loo, G. Liu; North China; (U.S.N.M.) Foochow; (Heude) Yangkiaping.

Hosts: *Artemisia* sp., *Beta vulgaris* Linn. (Europe).

China: Chahar (Yangkiaping); Hopei (Peiping[2,10]); Hupeh (Chang-yang); Mongolia[3]; Fukien (Foochow); Kwangsi (Ping-loo); eastern China[3]; Taiwan (Hokuseki[11]). March to July.

Distribution: Eastern Europe[1,4,5]; Siberia[3,6,7,8]; China; Japan[3] (Honshu[9]); Taiwan.

The writer feels that all of the above aberrational or varietal names are to be considered as synonyms since they are all based on color characters which appear in different parts of the range of the species and do not represent geographical subspecific characters. Certain of the color forms are more dominant in particular areas and therefore no doubt have a genetic basis, but apparently there has not been sufficient isolation of populations to allow raciation to proceed to the point of production of recognizable subspecies.

Cassida (s. str.) **mandli** Spaeth

(Plate 29, figure 7)

Cassida (Cassida) Mandli Spaeth, 1921, Koleopt. Rundschau, 9:84[1]; 1926, Best.-Tab. Eur. Col., 95:37 (synopsis). (Type in Spaeth collection.)

Dorsum dirty ochaceous brown, slightly paler on lateral portions of elytral discs; ventral surfaces of body, including head and coxae, black; abdomen bordered with pale reddish; legs, including trochanters, yellowish; antennae ochraceous with distal five segments pitchy black.

Body elongate-oval in dorsal outline, nearly one-half again as long as broad and slightly less than one-third as deep as broad, almost equally declivitous anteriorly and posteriorly. Pronotum somewhat less than twice as broad as long, obtusely rounded anteriorly; lateral angles subacute, touching humeral angles of elytra; surface entirely, and rather closely, punctured. Elytra no broader than pronotum basally, slightly broader at middle, subacute apically and non-tuberculate at summit; disc of each in part regularly punctured; punctures in about 12 rows, third to fifth rows and ninth to eleventh rows somewhat confused. Length 6.5 mm.; breadth 4.2 mm. According to Spaeth the male measures 6 x 4.3 mm. and the female 7 x 4.5 mm.

Some (Heude) Hsiao-ling, July, 1937; Antung, June, 1931.

China: Manchuria (Hsiao-ling, Antung).

Distribution: Ussuri[1]; northeastern China.

Cassida (s. str.) **mongolica** Boheman

Cassida mongolica Boheman, 1854, Mon. Cassid., 2:449[1]; Kraatz, 1879, Deutsche Ent. Zeits., 23:268[2]; Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (130, 139)[3]; 1926, Best.-Tab. Eur. Col., 95:35[4]; Chujo, 1934, Sylvia, 5:177. (Type in Stockholm Museum.)

Cassida russata Fairmaire, 1887, Revue d'Ent., 6:335[5].

Reddish brown to entirely black above except for a pair of pale spots at middle of anterior border of pronotum; black with five basal segments reddish.

Short, ovate; moderately convex. Prothorax as wide as elytra; sides obtusely angulate anterior to base; medially convex, coarsely and densely rugulose-punctate, smoother in middle. Elytra with humeri angulate; discs coarsely and irregularly substriate-punctate, first three rows fairly regular with intervals slightly raised but interrupted; fourth interval more strongly raised behind middle; explanate margins punctate; humeri obliquely costate. Length 7.5–8 mm.; breadth 4.8–6 mm.

China: Monogolia[1]; Hopei (Peiping[5]); Shantung (Kiautschou[3]).

Distribution: Eastern Siberia[2]; North China; northern Japan[4].

Cassida (s. str.) **nebulosa** Linnaeus

Cassida nebulosa Linnaeus, 1758, Syst. Nat., ed. 10:363[1]; 1767, ed. 12; 1, 2:575; 1761, Fauna Suec., ed. 2:152; Olivier, 1808, Ent., 6:979; 97, pl. 2, fig. 31; Stephens, 1831, Ill. Brit. Ent., 4:367; Suffrian, 1844, Stett. Ent. Ztg., 5:277; Boheman, 1854, Monogr. Cassid., 2:451; Baly, 1874, Trans. Ent. Soc. London, 1874; 213[2]; Kraatz, 1879, Deutsche Ent. Zeits., 23:267, 270[3]; Gorham, 1885, Proc. Zool. Soc. London, 1885:282[4]; Matsumura, 1907, Thousand Ins. Japan, 4:40, pl. 58, fig. 36 ♀; Spaeth, 1926, Best.-Tab. Eur. Col., 95:30; Yokoyama, 1931 (Col. Japan), 2:19, pl. 3, fig. 3; Matsumura, 1931, 6,000 Illus. Ins. Japan: 226, fig. 622; Yuasa, 1932, in Nippon Konchu Zukan: 586, fig. 1146; Chujo, 1934, Sylvia, 4:172; Liu, 1936, Lingnan Sc. Jl., 15:259[5]; 1938, Mushi, 11:168[6]; Gressitt, 1938, Lingnan Sc. Jl., 17:588[7]; 1939, Pan-Pac. Ent., 15:142[8]. (Type in the collection of the Linnean Society of London.)

Cassida affinis Fabricius, 1775, Syst. Ent.: 88[9].

Cassida maculata Fabricius, 1775, l. c.[10].

Cassida tigrina DeGeer, 1775, Mem. Ins., 5:168, pl. 5, figs. 15, 16[11].

Cassida nigra Herbst, 1799, Natursyst. Käfer, 8:258, pl. 131, fig. 12[12].

Dorsal surfaces testaceous brown, slightly reddish brown on pronotal disc; elytra marked with numerous small black dots or short longitudinal lines, some slightly larger black spots on inner portions of explanate margins in posterior half; antennae testaceous brown basally, pitchy apically; ventral surfaces black, abdomen with testaceous margin; legs with femora except apices pitchy black, remainder testaceous to pitchy. Body evenly oval; prothorax one-half as long as broad and rounded at sides; pronotum entirely punctured, a few swellings on disc; elytra entirely punctured, discs with regular rows of punctures separated by less than their diameters. Length 5–7.5 mm.; breadth 4.3–4.7 mm.

Some (Ac. Sin.) Manchuli and Pokotu, July; (C.A.S.) Kiangsu, July, 1923, Van Dyke collection; (U.S.N.M.) "O Er," 2,500–3,000 meters, near Weichow, August 6–18, D. C. Graham; (Heude) Hsiao-ling, June, 1937.

Hosts: *Atriplex* sp., *Chenopodium* sp., *Convolvulus* sp. (Europe), *Beta vulgaria* Linn. (Japan), thistles (Europe and Japan).

China: Manchuria[8] (Mukden, Hsiao-ling); Hupeh (Hwang-mei[7]); Shantung (Lao Shan[6]); Kiangsu[5]; Szechuan (O-er). May to August.

Distribution: Europe[1,9,10,12]; Siberia[3,11]; North China[2]; Korea; Japan[2,4].

Cassida (s. str.) **nucula** Spaeth

Cassida nucula SPAETH, 1914, Ent. Mitt., 3:228[1]. (Type in Spaeth collection.)

Reddish yellow; moderately shiny; each elytron with two pitchy spots on second interstice behind middle; ventral surfaces black except for head, femoral apices, tibiae, tarsi, antennae and outer margin of abdomen.

Rounded-subquadrate, feebly convex. Prothorax more than twice as broad as long, transversely elliptical; lateral angles subacute, placed barely anterior to middle of prothorax; disc and explanate margin finely but distinctly punctured. Elytra one-sixth broader than prothorax, weakly emarginate basally; humeri moderately prominent, subacute; sides subparallel; discs moderately swollen, feebly concave in basal triangle, regularly striate-punctate; suture feebly raised behind scutellum; explanate margins declivitous, finely rugulose-punctate. Length 4 mm.; breadth 3.5 mm.

China: Yunnan[1].

Distribution: Southwestern China.

Cassida (s. str.) **pallidicollis** Boheman

(Plate 29, figure 4)

Cassida pallidicollis BOHEMAN, 1856, Cat. Col. Ins. Brit. Mus., 9:138[1]; 1862, Mon. Cassid., 4:340; FAIRMAIRE, 1888, Revue d'Ent., 7:158[2]; SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (130, 139)[3]; 1926, Best.-Tab. Eur. Col., 95:32; DOI, 1927, Dobutsug. Zasshi, 39:335, 337; MATSUMURA, 1931, 6,000 Illus. Ins. Japan: 226, fig. 623, female; CHUJO, 1934, Sylvia, 5:175. (Type in Stockholm Museum.)

Cassida diabolica KRAATZ, 1879, Deutsche Ent. Zeits., 23:142[4].

Cassida (Mionycha) Morawitzi JACOBSON, 1894, Horae Soc. Ent. Ross., 28:245[5].

Cassida pallidicollis ab. *morawitzi*, SPAETH, 1942, Arb. morphol. taxon. Ent. Berlin-Dahlem, 9:12 (Erzendjanzsy, Manchuria).

Pronotum pale reddish brown; scutellum brown to pitchy; elytra almost entirely black to reddish brown tinged with pitchy near humeri and irregularly along suture or on disc; ventral surfaces reddish brown to black with brown legs and abdominal borders.

Dorsal outline rounded-oval, slightly longer than broad; strongly convex, steeply declivitous posteriorly. Prothorax nearly twice as broad as long, broadly rounded laterally, rugose-punctate. Elytra at bases slightly broader than prothorax; humeri subrounded, not very prominent; discs densely subseriate-punctate, second interspace strongly carinate, connecting anteriorly with slightly raised suture behind scutellum and with middle of base; explanate margins shallowly and coarsely rugose-punctate. Length 5.6–6.2 mm.; breadth 4.5–5 mm.

Specimens (Heude) Shanghai, Cheng-kiang, Zo-ce, April-May; (M.C.Z) Peiping, July, 1937, Kiu-hua Shan, September, 1932. K. C. Liu; (C.A.S.) Nanking, June; Mukden, August, 1923, E. C. Van Dyke; (A.M.N.H.) Tai-yuan-fu.

China: Mongolia[3]; Manchuria (Mukden); Hopei (Peking[2]); Shansi (Tai-yuan); Anhwei (Kiu-hua Shan); Kiangsu (Nanking). April to September.

Distribution: China[1] (northern and eastern); Korea[3]; eastern Siberia[4]; western Siberia[5].

Cassida (s. str.) **piperata** Hope

Cassida piperata Hope, 1842, Proc. Ent. Soc. London, 1:62[1]; 1845, Trans. Ent. Soc. London, 4:12; Boheman, 1862, Mon. Cassid., 4:322; Weise, 1900, Arch. f. Naturg., 66, 1:295; Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (130)[2]; Suppl. Ent., 3:19[3]; 1926, Best.-Tab. Eur. Col., 95:30[4]; Chujo, 1934, Sylvia, 5:174[5]; 1936, Mushi, 11:169[6]; Gressitt, 1939, Pan-Pac. Ent., 15:143[7]. (Type in British Museum.)

Cassida labilis Boheman, 1854, Mon. Cassid., 2:402[8].

Cassida biguttulata Kraatz, 1879, Deutsche Ent. Zeits., 23:275[9].

Coptocycla sparsa Gorham, 1885, Proc. Zool. Soc. London, 1885:284[10].

Dorsal surfaces testaceous, slightly reddish on pronotal disc; marked with black behind center of pronotum and irregularly on elytral discs, particularly at sides; elytral explanate margins each with a black patch on posterolateral portion and a narrower patch at suture; ventral surfaces black; head, antennae, and legs testaceous.

Oval in dorsal outline, broadly rounded anteriorly and posteriorly, widest at middle; moderately convex. Pronotum transversely oval, about twice as broad as long, broadly rounded at sides, densely punctured on disc. Elytra with humeri declivitous, slightly projecting beyond sides of pronotum, rounded-squarish; disc densely punctured in regular rows, with alternate interspaces more strongly raised, in part. Length 4–5.4 mm. breadth 3.3–3.6 mm.

Some (Lingnan) Shaowu, Chungan, Chang-ting, Maa; Canton; (W.C.U.U.) Paohsin, July, D. S. Pen; (M.C.Z.) Peking, July, 1932, Gaines Liu; (C.A.S.) Riran; (U.S.N.M.) Kyoto, Donckier collection; Yachow, 1,500 meters, June, 1929, D. C. Graham.

Host: *Alternanthera sessilis* R. Br. (Canton).

China: Hopei (Peking); Shantung (Tsingtau[6]); Kiangsu (Nanking[7]); Fukien (Shaowu, Chungan, Chang-ting); Kwangtung (Canton); Sikang (Yachow, Paohsin); Formosa[3,5] (Taihorin, Bakurasu, Hori, Karenko, Taihoku, Riran). Year-round at Canton.

Distribution: North[4] and eastern China[1,8]; Taiwan; eastern Siberia[9]; Korea[4]; Japan[1,2,10]; Tonkin[4]; Luzon[4].

Cassida (s. str.) **prasina** Illiger

Cassida prasina ILLIGER, 1798, Käfer Preuss., 1:481[1]; WEISE, 1893, Ins. Deutschl., 6:1081, 1101; REITTER, 1912, Fauna Germ., 4:218; SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (146)[2].

Cassida viridana HERBST, 1799, Natursyst. Käfer, 8:224[3] (excl. illus.).

Cassida chloris SUFFRIAN, 1844; Stett. Ent. Ztg., 5:188[4]; BOHEMAN, 1854, Mon. Cassid., 2:384; KRAATZ, 1874, Berl. Ent. Zeits., 18:92.

Cassida sanguinolenta var. *prasina*, DESBROCHERS, 1891, Mon. Cassid. (Frelon): 40.

Cassida (Cassida) prasina, SPAETH, 1926, Best.-Tab. Eur. Col., 95:50.

Dorsal surfaces green; posterior part of pronotum shiny silvery; basal portions of elytra often blood-red with shiny silvery raised areas; ventral surfaces black; legs greenish.

Body rounded-ovate. Pronotum with lateral angles acute, placed near base. Elytra seriate-punctate, with weakly raised longitudinal ridges. Length 4.3–6.0 mm.; breadth 3–4 mm.

One (C.A.S.) Karuisawa, Honshu, Japan, July 1–5, 1950, Gressitt.

Host: *Achillea millefolium* Linn. (Europe).

China: Sinkiang (Tien Shan, Ala-tau[2]).

Distribution: Europe[1,3,4]; central Asia[2]; Japan (Honshu).

Cassida (s. str.) **probata** Spaeth

Cassida probata SPAETH, 1914, Ent. Mitt., 3:277[1]. (Type in Spaeth collection.)

Shiny; dorsal surfaces yellow with pronotal and elytral discs almost entirely black; ventral surfaces black with coxae yellow; head black; antennae yellow basally, pitchy beyond middle.

Rounded in dorsal outline, slightly longer than broad; moderately convex. Prothorax about one-half again as broad as long, elliptical, transversely symmetrical, rounded at lateral angles; disc smooth with fine scattered punctures. Elytra but slightly broader at bases than prothorax; humeri slightly produced, subacute, forming right angles; disc feebly impressed in basal triangle, with hardly a suggestion of a postscutellar tubercle, but with some of interspaces raised, forming a weak reticulation; punctures fairly large and not very regular; explanate margins weakly rugulose-punctate. Claws simple. Length 6 mm.; breadth 4.7 mm.

China: Yunnan[1].

Distribution: Southwestern China.

Cassida (s. str.) **rubiginosa rugosopunctata** Motschulsky

Cassida rugosopunctata Motschulsky, 1866, Bull. Soc. Nat. Mosc., 39, 1:177[1]; Kraatz, 1879, Deutsche Ent. Zeits., 23:273. (Type in Moscow Museum ?.)

Cassida erudita Baly, 1874, Trans. Ent. Soc. London, 1874:212[2]; Kraatz, 1879, Deutsche Ent. Zeits., 23:273.

Cassida rugoso-punctata, Gorham, 1885, Proc. Zool. Soc. London, 1885:281.

Cassida rubiginosa Weise, 1900, Arch. f. Naturg., 66, 1:294.

Cassida rubiginosa var. *rugosopunctata*, Spaeth, 1914, Col. Cat., 62:109; 1926, Best.-Tab. Eur. Col., 95:44[3]; Yokoyama, 1931 (Col. Japan), 2:18, pl. 3, fig. 2; Chujo, 1934, Sylvia, 5:177[4].

Dorsal surfaces brownish green to distinct pale green with scutellum, bases of elytra near scutellum and extreme outer borders of explanate margins of prothorax and elytra brownish; antennae with basal half reddish testaceous and distal half pitchy black; ventral surfaces of body black; legs largely black on femora, reddish testaceous on coxae, tibiae, and tarsi.

Body fairly flat, even in dorsal outline. Prothorax nearly as broad as elytra at base. Dorsum entirely punctured, including explanate margins, subseriately so on elytra. Length 7–7.8 mm.; breadth 5.8–6.5 mm.

Several (C.A.S.) Hangchow, May, 1923, Nanking, April-May, E. C. Van Dyke; (A.M.N.H.) Yen-ping, Spring, 1915, Caldwell; (M.C.Z.) Chang-yang, 1,500 meters, near Ichang, July, 1887, A. E. Pratt.

China: Fukien (Yen-ping); Chekiang (Hangchow); Kiangsu (Nanking); Hupeh (Ichang); Tibet[3].

Distribution: Tibet; East China[3]; Korea[3]; Saghalien[4]; Japan[1] (Hokkaido[4]; Honshu[1,2]).

Cassida (s. str.) **rubiginosa taiwana** Gressitt, new subspecies

Dorsal surfaces dull brownish green; borders and punctures of elytral explanate margins paler; elytral disc with extreme base from inner edge of humeral callus to scutellum and suture along basal fifth reddish brown, presumably brighter red in life; remainder of suture very narrowly brownish;

ventral surfaces of body black; posterolateral border of abdomen reddish testaceous; legs reddish brown with coxae, trochanters and femora to just before apices, black; antenna reddish brown, blackish on scape and pitchy on last five segments.

Body oblong-oval in dorsal outline, fairly narrow and subparallel-sided, about one-third as deep as wide. Head about as long as broad; frontoclypeal area trapeziform, slightly longer than broad, flat and distinctly punctured. Antenna hardly reaching to posterolateral angle of pronotum, distinctly thickened slightly beyond middle; third segment fully one-half again as long as second and slightly longer than fourth; fourth longer than fifth or sixth. Pronotum not quite as broad as elytra at humeri, nearly twice as broad as long, strongly rounded anteriorly; lateral angles subrounded-angulate, nearly right angles, very near base in longitudinal sense; basal margin sinuate; disc and explanate margin hardly differentiated on surface, deeply and closely punctured. Scutellum triangular, longer than broad. Elytra distinctly longer than broad, subparallel-sided, very slightly wider just before middle than at bases; suture hardly raised behind scutellum; disc of each elytron with about 12 subregular rows of fine punctures, the interspaces partly punctate and the rows completely confused posterolaterally; second interspace somewhat raised; explanate margins about one-third as wide as discs, declivitous at an angle of about 35 degrees, irregularly punctured. Ventral surfaces of body finely and sparsely punctured. Length 7.6 mm.; breadth 4.7 mm.

Holotype, probably a male (California Academy of Sciences), **Pianan-Ambu,** altitude 1,900 meters, **southwest of Tai-ping Shan (Taiheizan), Tai-chung District, northcentral Taiwan,** May 11, 1932, Gressitt.

Differs from *C. r. rubiginosa* Müller in being less oval, more nearly parallel-sided, with the humeri slightly broader than the pronotum, the pronotal disc more coarsely punctured and the elytral discs more densely and less regularly punctured, and from *C. rubiginosa rugosopunctata* Motsch. in being narrower, more nearly parallel-sided, more densely punctured on the pronotum and with the explanate margins of the elytra narrower. The new subspecies differs from both the above in being more brownish and less greenish in the dried state.

Distribution: Taiwan.

Cassida (s. str.) **sikanga** Gressitt, new species

(Plate 30, figure 8)

Somewhat shiny reddish brown; antenna testaceous on basal half, pitchy black distally, with base of scape pitchy and apex of last segment slightly pale; head black; frontoclypeus reddish pitchy; thoracic and abdominal sternites pitchy black, the latter testaceous on outer borders; legs pitchy black.

Head subrounded; frontoclypeal area trapeziform, slightly broader than long, subrounded anteriorly, irregularly punctured, with bordering groove narrow; vertex medially grooved, a slight forward projection on each side of front of occiput. Antenna reaching slightly beyond humeral angle, slender basally, thickened distally; second segment two-thirds as long as scape; third a little longer than second, barely longer than fourth; fifth as long as fourth, slightly longer than sixth, which is slightly thickened distally; seventh to tenth much thicker; tenth nearly as broad as long; eleventh twice as long as tenth, tapering in distal half. Prothorax almost twice as broad as long, transversely subelliptical, but somewhat sinuate basally, with prescutellar projection prominent and emarginate-truncate; anterior margin subevenly convex; lateral angles subobtusely rounded, placed just behind middle in longitudinal sense; disc subevenly convex, slightly irregular, in large part subcoarsely though shallowly punctured, but smoother, finely punctured and less raised on supracephalic area, slightly concave just anterior to scutellum; explanate margin nearly flat except anteriorly, forming a shallow concavity on each side in connection with sides of disc, subevenly impressed with moderate, distinct punctures. Scutellum subequilateral; basal margin slightly convex in outline. Elytra subparallel-sided, narrowed and broadly rounded posteriorly; humeral angle of each rounded, projecting only slightly forward, not very close to lateral angle of prothorax; suture moderately raised behind scutellum; disc with ten subregular rows of moderate punctures, mostly narrower than interspaces, and with some partial transverse corrugations; some extra punctures in basal triangle and between third and fourth puncture-rows anterior to middle, both of which areas are depressed; also a shallow sublongitudinal depression in area of fifth to seventh puncture-rows posterior to middle; explanate margin moderately declivitous, somewhat wrinkled or uneven, but with punctures fine or indistinct. Ventral surfaces and legs moderately wrinkled or punctured. Length 6.3 mm.; breadth 4.4 mm.

Holotype (West China Union University), **Pao-hsin, Sikang Province, West China,** July 8, 1939, Miss D. S. Pen.

Differs from *C. fuscorufa* Motsch. in being relatively broader and less convex, with the pronotum flat at sides, less convex, with its lateral angles more rounded and placed more nearly at middle in longitudinal sense and with the elytra more evenly convex and more finely punctured; and from *C. jacobsoni* Spaeth in having the explanate margins a little narrower, the elytra less strongly raised behind scutellum and the pronotal explanate margin more rounded at sides and more sparsely punctured.

Distribution: West China.

Cassida (s. str.) **spaethi** Weise

Cassida spaethi Weise, 1900, Deutsche Ent. Zeits., 1900:458[1]; Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (130)[2]; 1914, Col. Cat., 62:111[3]. (Type in Zoological Museum of Berlin ?.)

Cassida stigmatica, Kraatz (*not* Suffrian), 1879, Deutsche Ent. Zeits., 23:267[4].

Cassida Kraatzi Weise, 1900, Arch. f. Naturg., 66:295[5].

Cassida (Cassida) Spaethi, Spaeth, 1926, Best.-Tab. Eur. Col., 95:46.

Cassida spaethi subsp. *mandschukuoensis* Spaeth, 1942, Arb. Morph. Tax Ent. Berlin-Dahlem, 9:13[6].

Green, shiny; ventral surfaces black; antennae (except clubs), legs and borders of abdomen testaceous.

Broadly ovate, fairly convex. Prothorax short, transversely subelliptical, rounded laterally, punctate. Elytra evenly emarginate and crenulate basally, prominent at humeral angles, strongly seriate-punctate on discs with second interspace elevated. Length 6–7 mm.; breadth 5 mm.

I have not seen this species and do not know whether two subspecies are involved in China or not. In naming *C. s. mandschukuoensis*, Spaeth stated that the typical form was found in Ussuri, Amur, Vladivostok and Korea (Seishin).

China: Mongolia[2]; Manchuria[6] (Erzendjanzsy).

Distribution: North China; Siberia (Amur[1,4,5], Askold[3]); Korea[3].

Cassida (s. str.) **stigmatica** Suffrian

Cassida stigmatica Suffrian, 1844, Stett. Ent. Ztg., 5:206[1]; Boheman, 1854, Mon. Cassid., 2:385; Kraatz, 1874, Berl. Ent. Zeits., 18:88; Reitter, 1912, Fauna Germ., 4:217; Spaeth, 1914, Col. Cat., 62:111[2]; 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (146)[3]; Wu, 1937, Cat. Ins. Sin., 3:922. (Type in Stettin Museum ?.)

Cassida Brucki (Becker ms.) Gemminger & Harold, 1874, Cat. Col., 12:3658[4].

Cassida fenestrata (Megerle ms.) Gemminger & Harold, 1874, l. c.[5].

Cassida singularis (Sturm ms.) Gemminger & Harold, 1874, l. c.[6].

Cassida sanguinolenta var. *stigmatica*, Desbrochers, 1891, Mon. Cassid. (Frelon):24.

Cassida (Cassida) stigmatica, Spaeth, 1926, Best.-Tab. Eur. Col., 95:46.

Dorsal surfaces green with bases of elytra splotched with blood-red; ventral surfaces black; legs greenish.

Ovate; strongly convex. Pronotum with lateral angles broadly rounded and surfaces densely and strongly punctured. Elytra broader than pronotum; humeri prominent; disc of each seriate-punctate with interpunctural areas forming weak longitudinal ridges; second interspace strongly raised anteriorly. Length 5–6 mm.; breadth 3.5–4 mm.

Host: *Achillea millefolium* Linn. (Compositae).

China: Sinkiang (Tien Shan, Kuldja[3]).

Distribution: Central Europe[1,4,5,6]; central Asia; Siberia[2].

Subgenus **Odontionycha** Weise

Odontionycha Weise, 1891, Wiener Ent. Ztg., 10:204; 1893, Ins. Deutschl., 6:1074; Bedel, 1898, Faune Col. Bassin Seine, 5:207; Spaeth, 1912, Ann. Mus. Nat. Hung., 10:498; 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (135); 1926, Best.-Tab. Eur. Col., 95:23, 24.

Body broad and fairly flat, elongate-ovate in dorsal outline, narrowed posteriorly. Pronotum strongly transverse, rounded near middle of each side, feebly convex. Elytra feebly raised behind scutellum, irregularly punctured; explanate margins punctured, slightly declivitous, not very distinctly set off from discs. Antennae just reaching to humeral angles, thickened distally. Tarsal claws large, toothed basally, barely reaching beyond end of third tarsal segment.

Subgenerotype: *Cassida viridis* Linneaus (Palearctic region).

Range: Palearctic and Ethiopian regions.

This subgenus hitherto contained two Palearctic species and several inhabiting Africa, most of them in South Africa.

Key to the Chinese Species of Odontionycha

1. Dorsal body outline oblong-oval, hardly broader at humeri than posterolaterally; body nearly one-half as deep as broad; color pale testaceous in dried specimens .... *O. inflata*

— Dorsal body outline ovate, much broader anteriorly than posteriorly; body about one-third as deep as broad; color greenish .... *O. viridis*

Cassida (Odontionycha) inflata Gressitt, new species

(Plate 30, figure 9)

Dried specimen: Pale whitish straw-color, very pale brownish on part of posterior portion of elytral disc; head partly pitchy, pale on center and lateral borders of frontoclypeal area; antennae brownish on scape, pale on next four and one-half segments, pitchy black on remainder, but apex of last segment partly paler; ventral surfaces pitchy along middle, testaceous to brownish at sides; legs pitchy reddish brown. Dorsum glabrous.

Head round; eyes large; frontoclypeal area subtrapeziform, broader than long, in outline slightly convex at apex, somewhat concave at base, with about 20 distinct punctures; labrum depressed and emarginate apically. Antenna slender, barely reaching to humeral angle; scape stout, nearly twice as long as second segment; third segment distinctly longer than second, barely longer than fourth; fifth equal to fourth; sixth shorter, flattened and broadened distally; seventh to tenth subequal, flattened and broadened, nearly as broad as long; last barely twice as long as tenth, somewhat flattened, tapering from just beyond middle. Prothorax a little less than twice as broad as long, distinctly narrower than elytra, somewhat evenly convex in anterior outline, broadly rounded at each side, emarginate-truncate at middle of base; disc somewhat gradually declivitous from median line, concave on each side of center, indistinguishably merging with explanate margin, the whole set with fairly close, small distinct punctures. Scutellum triangular, slightly broader than long, slightly convex in outline on each side, irregularly punctured. Elytra broad, slightly widened behind humeri, broadly rounded posteriorly, strongly raised along suture behind scutellum in a large arch, in side view evenly declivitous from summit to extreme apex and somewhat evenly, though more gradually, declivitous from summit to anterior margin of prothorax; disc of each elytron rather smooth and even, finely, and in large part irregularly, punctured; basal margin narrowly black, crenulated; explanate margin moderately inclined anteriorly, forming a wide angle with side of disc, more sparsely and heavily punctured than disc; humerus produced somewhat forward, rounded, approaching middle of side of pronotum. Ventral surfaces moderately wrinkled or punctured; prosternum with large shallow punctures. Length 7 mm.; breadth 5.2 mm.

Holotype (California Academy of Sciences), **Suisapa,** altitude 1,000 meters, **Lichuan District, western Hupeh Province, West China,** July 25, 1948, Gressitt.

Differs from *C. viridis* Linn. in being more evenly oblong-oval in dorsal outline and much more convex in lateral outline, nearly one-half as deep as broad, in having the prothorax much more broadly rounded at sides, more convex and more punctate on disc and the elytra with discs more finely punctured and explanate margins smoother and more distinctly punctured.

Distribution: Westcentral China.

Cassida (Odontionycha) viridis Linnaeus

Cassida viridis LINNAEUS, 1758, Syst. Nat., 10, 1:362[1]; REITTER, 1912, Fauna Germ., 4:213, pl. 150, fig. 11 a-b; SPAETH, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (135); 1926, Best.-Tab. Eur. Col., 95:25[2]; MATSUMURA, 1931, 6,000 Illus. Ins. Japan: 266[3], fig. 624; CHUJO, 1934, Sylvia, 5:166. (Type in collection of the Linnean Society of London.)

Cassida equestris FABRICIUS, 1787, Mant. Ins., 1:62[4]; GORHAM, 1885, Proc. Zool. Soc. London, 1885:281[5]; MATSUMURA, 1907, 1,000 Ins. Japan, 4:39, pl. 68, fig. 35; YOKOYAMA, 1930 (Col. Japan), 1:29, pl. 3, fig. 7.

Dorsal surfaces pale green: pronotum partly brownish green on disc, yellowish on borders, and part of anterior portion, of explanate margin; elytra with discal punctures on outer borders of discs slightly brownish and explanate margins with outer borders and punctures yellowish; ventral surfaces black with borders of pro- and mesothorax and abdomen reddish brown; antennae reddish brown with last four segments pitchy.

Dorsal outline somewhat kite-shaped: obtuse anteriorly and narrowed posteriorly; body flattened, less than one-third as deep as wide. Pronotum almost three-fifths as broad as long, obtusely convex anteriorly, subsinuate basally; lateral angles broadly rounded and placed somewhat behind middle; surfaces entirely punctured. Elytra one-fourth broader than pronotum, widest just anterior to middle; humeri rounded, somewhat declivitous and almost forming an even line with margin of pronotum; discs feebly raised at suture behind scutellum, finely and irregularly punctured; explanate margins one-half as wide as discs, slightly declivitous, also punctured. Length 8–10 mm.; breadth 6.3–7 mm.

Not yet recorded from China, though listed from Siberia, Japan, and northern Asia.

Hosts: *Salvia, Stachys, Mentha, Galeopsis, Lycopus, Circium* spp[2] (Europe).

Distribution: Europe[1,4]; Siberia[2]; Japan (Honshu[3,5]; Hokkaido[3]).

Subgenus **Cassidulella** Strand

Cassidula WEISE (*not* Humphrey, 1797), 1889, Wiener Ent. Ztg., 8:260; 1891, op. cit., 10:204; 1893, Ins. Deutschl., 6:1076; SPAETH, 1926, Best.-Tab. Eur. Col., 95:24, 53; CHUJO, 1934, Sylvia, 5:165, 169.

Cassidulella STRAND, 1928, Ent. Nachr. Bl., 2:2 (n. n.).

Body slender, strongly convex; dorsal outline narrowly oval. Antennae short, moderately thickened, reaching humeral angles. Pronotum broader than long, convex anteriorly, subtransverse along basal margin of disc; lateral angles rounded-obtuse, at middle of sides. Elytra much longer than broad, hardly broader than pronotum, seriate-punctate with punctures in third inter-punctural area; explanate margins strongly declivitous. Tarsal claws untoothed. Middle coxal cavities close.

Subgenerotype: *Cassida vittata* Villers (Palearctic region).

Range: Palearctic region.

KEY TO THE CHINESE SPECIES OF CASSIDULELLA

1. Head reddish yellow; femora largely testaceous; pronotum closely and finely punctured, broadest anterior to middle; elytra with discal punctures finer than marginal punctures .... *C. parvula*

— Head black; femora black except for apical portions; pronotum closely and coarsely punctured, broadest at middle; elytra with discal punctures heavier than those of explanate margins .... *C. velaris*

Cassida (Cassidulella) parvula Boheman

Cassida parvula Boheman, 1854, Mon. Cassid., 2:428[1]; Weise, 1889, Horae Soc. Ent. Ross., 23:571, 646[2]; 1893, Ins. Deutschl., 6:1082[3]; Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): 146[4]. (Type in Stockholm Museum.)

Cassida navicula Boheman, 1854, Mon. Cassid., 2:429[5].

Cassida comparata Rybakow, 1889, Horae Soc. Ent. Ross., 23:289[6]; Jacobson, 1910, Revue Russe d'Ent., 10:60.

Cassida (Cassidula) parvula, Spaeth, 1926, Best.-Tab. Eur. Col., 95:57[7]; Chujo, 1938, Mushi, 11:168[8].

Pale yellow dorsally; elytra each with a silver stripe; ventral surfaces black, except for labrum, antennae, femora, tibiae, tarsi, and borders of abdomen which are straw yellow.

Form elliptical, rather strongly convex. Prothorax subsemicircular, rounded at posterolateral angles, finely punctured; elytra regularly and deeply punctate-striate, second interspace with a narrow shiny silver stripe, explanate margins punctured. Length 4.5–5 mm.

China: Sinkiang (Kuldja[4]); Tsinghai (Kokonor, Amdo[6]); Mongolia[1] (Ordos[2]); Hopei (Tientsin[7]); Shantung (Lao Shan[8]). June.

Distribution: Caspian Sea[5]; Central Asia (Turkestan, etc.); North China; Siberia[3].

Cassida (Cassidulella) velaris Weise

Cassida velaris Weise, 1896, Deutsche Ent. Zeits., 1896:281[1]; Spaeth, 1914, Verh. Zool.-Bot. Ges. Wien, 64 (Sitzb.): (146)[2]. (Type in Berlin Museum ?.)

Cassida (Cassidula) velaris, Spaeth, 1926, Best.-Tab. Eur. Col., 95:54[3]; Chujo, 1934, Sylvia, 5:169.

Pale testaceous; suture and elytral punctures pitchy; ventral surfaces of body black; tibiae, tarsi, apices of femora and external margins of sternites testaceous.

Body elliptical in dorsal outline, strongly convex. Head punctate; triangular portion of frontoclypeal area terminating in a deep, narrow groove anteriorly. Pronotum deeply punctured; lateral angles rounded-obtuse, at middle of sides. Elytra convex, sides of disc and explanate margins steeply declivitous; disc regularly and deeply punctured, with extra punctures in third interpunctural area. Length 4.8–5.2 mm.; breadth 3.2 mm.

One (U.S.N.M.) Kyoto, Honshu.

China: Tsinghai (Kokonor[2]).

Distribution: Eastern Siberia[1] (Ussuri[3]); Tsinghai; Japan[2] (Honshu).

Subgenus **Tylocentra** Reitter

Tylocentra REITTER, 1926, in Spaeth and Reitter, Best.-Tab. Eur. Col., 95:24, 57.

Body strongly convex, oval or ovate in dorsal outline. Elytra slightly tuberculate at summit, declivitous at sides; explanate margins steeply declivitous, extending below venter, forming a cavity. Ventral surfaces of body green or yellow. Middle coxae widely separated. Tarsal claws widely divergent, untoothed.

Subgenerotype: *Cassida virguncula* Weise (Mongolia); by present designation.

Range: Southern Palearctic (Asia Minor to North China).

KEY TO THE CHINESE SPECIES OF TYLOCENTRA

1. Elytra with a distinct tubercle at summit; basal triangle of each elytron distinctly impressed; interpunctural rows wider than punctures.............. 2

— Elytra lacking a distinct tubercle at summit; basal triangle of each elytron not distinctly impressed; puncture-rows entirely regular, wider than interpunctural areas ....*T. deltoides*

2.(1) Dorsal outline triangular-ovate, subangulate posteriorly; body slightly more than one-half again as long as broad; lateral angles of pronotum obtuse, slightly anterior to middle; elytral explanate margins feebly punctured ....*T. lenis*

— Dorsal outline nearly circular; but slightly longer than broad; lateral angles of pronotum bluntly angular, located at one-third distance from base to apex; elytral explanate margins indistinctly punctured..............*T. virguncula*

Cassida (Tylocentra) deltoides Weise

Cassida deltoides WEISE, 1889, Horae Soc. Ent. Ross., 23:571, 644[1]; SPAETH, 1914, Col. Cat., 62:101. (Type in Berlin Museum.)

Cassida (Tylocentra) deltoides, SPAETH, 1926, Best.-Tab. Eur. Col., 95:58.

Grass-green in life; somewhat shiny; basal triangle of elytra blood-red; dried specimens dirty green, brownish on pronotum and sides of elytra; head with convergent arcuate dark lines on frons.

Body but slightly longer than broad, ovate, strongly convex. Prothorax transversely almost elliptical, twice as broad as long, posterior angles fully rounded and surfaces shallowly rugose-punctate. Elytra subacutely produced at humeri, nearly reaching forward to transverse axis of pronotum, slightly broadened behind humeri to middle, strongly and deeply seriate-punctate with narrow, equal interspaces; suture raised behind scutellum, forming a plane anterior triangle, concave on each side of scutellum. Length 4.5–5 mm.

China: Mongolia (Ordos[1]). Late September.

Distribution: Northwestern China.

Cassida (Tylocentra) lenis Spaeth

Cassida (Tylocentra) lenis Spaeth, 1926, Best.-Tab. Eur. Col., 95:59[1]. (Type in Spaeth collection, Manchester.)

Greenish yellow, shiny, with red spots on suture and tubercle.

Body deep, strongly convex. Prothorax as broad at base as elytral bases, rounded anteriorly, with bluntly rounded sides, widest slightly anterior to middle. Elytra regularly and coarsely seriate-punctate; basal triangles feebly impressed; elytral explanate margins with small obsolescent punctures. Length 6 mm.; breadth 4 mm.

China: "China (Singley)"[1]. Presumably northwestern China.

Distribution: Northwestern China.

Cassida (Tylocentra) virguncula Weise

Cassida virguncula Weise, 1889, Horae Soc. Ent. Ross., 23:571, 645[1]; Wu, 1937, Cat. Ins. Sin., 3:922[2]. (Type in Berlin Museum.)

Cassida (Tylocentra) virguncula, Spaeth, 1926, Best.-Tab. Eur. Col., 95:58.

Brilliant green in life; dried specimens brownish yellow, shiny. Short, oval, broadest in basal third of elytra and from there regularly narrowed to posterolateral angles; body moderately convex. Prothorax nearly twice as broad as long, subsemicircular, with rounded posterolateral corners, feebly punctured, shiny; elytra with a flattened basal triangular area, slightly concave on each side of scutellum, regularly punctate-striate on discs, interspaces flattish, broader than puncture-rows and minutely punctulate, humeral angles moderately produced, subacute, and explanate margins as steeply declivitous as discs and moderately closely punctured. Length 4.3–4.8 mm.

China: Shansi[1]; Mongolia[2]. June.

Distribution: Northwestern China.

BIONOMICS

The habits of the tortoise beetles are somewhat unusual, just as are the phenomena of the ephemeral golden iridescence and the broadly expanded lateral margins of the pronotum and the elytra in the adults.

Though the "parasol"-bearing larvae, or "peddlers" are familiar to many, it is perhaps not so generally known that the subfamily Cassidinae is one of the very few groups of insects, aside from the Blattaria and Mantodea, in which the females construct papery oothecae with which to protect their eggs. Furthermore, certain members of the Cassidinae are among the very few insects which lay their eggs attached to the ends of filaments, though in these beetles the eggs are pendant from the under surfaces of leaves, rather than standing erect on their stiff pedicels as in the Chrysopidae.

The oothecae of the Cassidinae exist in many different forms. Some consist of layers of papery material attached to each other at one end, others of individual transparent capsules, some of conglomerations of frothy material, some are filamentous as described above, and some appear like wax or amber, imbedding the eggs. All types are attached almost invariably to the under leaf surface of the host plant. Many types of oothecae have a smaller or greater amount of the mother's feces placed on top to further camouflage them. A key to the known oothecae of Chinese tortoise beetles follows the life history data.

The larvae all have a caudal appendage with muscular attachment, located above the anus. The latter is also highly muscular and is telescopically protrusible, often for at least one-half the length of the body. This is correlated with the ability to attach the feces to various parts of the accumulated exuviae, or to the caudal furca in the first instar larva. In some forms the exuviae are not fastened to the caudal furcae, being discarded, and the feces are formed into long filaments attached to the furcae. In still others the exuviae are closely matted, not covering most of the dorsum of the body, and the feces are attached to them in long, spreading filaments or massed filaments. The larvae always have lateral processes or spines arranged along the sides of the thoracic and abdominal segments. The normal arrangement for each side is three for the prothorax, three on the mesothorax, two on the metathorax, and one for each abdominal segment. They continue along the sides of the abdomen generally to the eighth segment, and the caudal furca or supraanal process represents, at least in analogy, the fused processes of the ninth abdominal segment. A key to the known larvae of Chinese Cassidinae follows the key to oothecae.

The pupae are in some respects very similar in appearance to the larvae. They are generally of the same usually green or brown color, are similarly dorsoventrally compressed, have fringing appendages around the borders, and usually have the same exuvial-fecal armature of the larvae with the addition of the exuviae of the fifth instar. Thus the pupae similarly possess the caudal furcae, which in some cases appear to be separated at their insertions. The lateral appendages of the abdomen frequently are in the form of broadly expanded plates with fringing spinules, or appear as long, sinuous spines. The appendages of the prothorax frequently consist of numerous short filaments or a few longer ones, though sometimes they are entirely lacking. The meso- and metathoraces have the wings substituted for the larval appendages. A key to the known Chinese pupae follows the key to larvae.

Life History of Aspidomorpha furcata (Thunberg) at Canton

(Plates 31, 32, and plate 36, figures 1, 4, and 7)

Host plants: This species attacks sweet potato *(Ipomoea Batatas* Lamk.), swamp cabbage *(Ipomoea Aquatica* Forsk.) and morning-glory *(Ipomoea cairica* Sweet and *Ipomoea digitata* Linn.)

Prevalence: During the warmer parts of the year the larvae and adults are very abundant, and destruction is extensive. It is common to see one-quarter or more of the leaf surfaces eaten by these beetles, sometimes assisted by the other two Canton sweet potato tortoise beetles discussed below. The adults are definitely diurnal, being most active as to flying and mating in the sunshine, though spending much of their time during the hottest part of the day on the undersides of the leaves, where most of the feeding and mating takes place. Egg-laying is likewise largely done during the day-time, on the under surfaces of the leaves. The larvae feed continuously, day and night, except for short intervals for rest and longer periods, of several hours or more, for molting.

Generations: The maximum number of generations is eight or nine per year, the life-cycle in the warmer seasons occupying four and one-half weeks and in the winter from six to eight weeks or much longer. In the case of cold winters (the temperature dropping to within a few degrees of freezing) development may actually cease and a sort of hibernation consisting of inactivity take place. The generations are irregular and overlapping, so that at almost any time the beetles may be found in all stages of development.

Eggs: The eggs are laid in small egg-cases (pl. 30, figs. 1, 2) on the under surfaces of the leaves. The cases are 3–3.5 mm. long and 2–2.75 mm. wide. The adult female produces a thin papery brown substance which is formed into oblong-oval slightly corrugated sheets which are glued at one end in layers to the leaf surface, one egg being laid between every two sheets, except for an extra sheet, smaller than the others, at both bottom and top. The position of each egg differs in regard to the rest, from side to side, to make for compactness, the corresponding sheets varying in width and position accordingly. The case may contain from one to eight eggs, and perhaps occasionally nine, but generally two to five, with the average about four. Table I will indicate the numbers of eggs hatched from 48 egg cases in reared groups. Fourteen egg cases obtained in captivity contained eggs as follows: two eggs (nine egg cases); three eggs (three cases); four eggs (one case); five eggs (one case); average, 2.57 eggs per case. Another group of 26 egg cases laid in captivity contained an average of 3.15 eggs per case. A group of 60 egg cases obtained by random collecting in the field contained an average of 4.028 eggs per case. Of this group 12.8 per cent of the eggs were found to be parasitized. It would seem that fewer eggs per case are laid in captivity. The egg stage lasts from 3.75 to 5.75 days in summer and from 5 to 10 days or more in winter.

Table I
Egg cases of *Aspidomorpha furcata*

Egg cases	Eggs hatched	Number of eggs per case Maximum	Minimum	Average
2	8	5	3	4
7	17	4	--	2.47
4	12	4	2	3
9	24	3	2	2.6
10	31	5	2	3.1
3	10	4	3	3.33
2	7	4	3	3.5
8	26	5	2	3.25
3	8	3	2	2.66
Total average per egg case				3.06

Larvae: There are five larval instars. The larva emerges by chewing the end of the thin membrane-like sac containing the ovum, and crawling out from the open free end of the egg case. The fully formed larva, with its spines folded backward along each side of its body, may be found in the egg some hours before the actual emergence takes place. Feeding begins shortly after the larva makes its exit from the case and the young larva eats only the under side of the leaf, not indulging in any of the upper epithelium till after the first molt takes place. During the second and following instars the larvae may eat holes of various sizes through the leaves, as do the adults. During feeding and locomotion, the larva may suddenly raise its caudal appendage when disturbed. Molting takes place after a rest of a few hours, and commences when the skin splits along the median line. This is pushed backwards as the larva crawls out until the skin is folded and rolled onto the end of the new caudal furca, with the previous caudal furca or furcae projecting from the distal end. Each successive molt is similar and the old larval skins, each larger than the preceding, form segments of the tapering ''parasol'' supported by the new caudal furca.

The first stadium lasts from one and three-fourths to three days in the warmer seasons, averaging about two days or so, and may last six days or longer in winter. The second generally lasts a few hours less than the first stadium, but may be as long as nine days or more in winter. The third and fourth each average about two and one-half days in length for all seasons, and the fifth somewhat over six days, including the prepupal period of two or three days. During the prepupal period no food is taken, the larva attaches the posterior end of its body to the surface of the leaf, and the transformations commence under the larval skin, the fully formed pupa being revealed with the molting of the skin of the fifth instar. In table II the lengths of the various stages in different seasons are tabulated from data on reared groups, and averaged.

Table II

Length of life-stages of *Aspidomorpha furcata* in days

			Larval stadia							
No.	Month	Egg	I	II	III	IV	V	Pupa	Egg to adult	Adult
9–98	Aug.	4.5	2	2	2.3	2	5.5	4.5	22.8	15–234
9–123	”	5	2	2	2	2	5	4	22	”
9–124	”	4.5	2	2	2	2	5	4	21.5	”
9–161	”	4.7	2.5	2	3	2.5	5	4	23.7	”
9–180	”	4.7	1.7	2.5	3	2.3	3.7	4.3	23.3	”
9–182	“	4.7	2	2	2	3	5	4.3	23.0	”
9–190	”	5	1.7	1.7	1.7	1.7	5	4.2	22.2	”
9–193	”	4.7	2.2	2.2	1.5	2.7	4	4	21.5	”
9–196	”	4.7	2	1.7	1.7	2	5	4	22.2	”
9–210	”	4.6	2	2	2	2	4.7	4	21.4	”
9–213	Sept.	4.6	2	2	2	2	4.5	4	21.1	”
9–220	”	4.5	2	2	2	2	5	4	21.5	”
9–228	”	3.7	3	2.5	1.5	2	5	4.2	22	”
9–240	”	4	2.5	1.7	2	2	5	4	21.2	”
9–255	”	4.5	1.7	1.7	1.5	2.5	5	4	21	30–98
9–293	”	4.5	2	2	3	2	6	5	24.5	30–98
9–350	”	5	2	2	3	3	5	10	30	15–158
9–607	Nov.	5–8	5	5	4	4	30	13	64.5	10–15
9–614	”	6–7	3	2	2	2	8	17	40.5	10–15
0–339	Dec.	13	5	6	4	4	10	13	55	—
1–21	April	5	3.5	2.5	3	2.2	5.5	4.5	26.2	—
1–38	June	5	4	3	2	3	4	5	26	—
M–6	”	6	6	6	2	2	5.5	6	33.5	148
M–10	”	5	3	2	2	3	6	5	26	75 (♀)
M–10A	”	5	3	2	3	3	6	5	27	129 (♂)
M–10L	”	6	2	3.5	1.5	3	8	5	29	—
Averages		5.1	2.6	2.5	2.5	2.6	6.3	5.3	26.9	121

Pupa: The pupa remains attached to the leaf surface with the “parasol” generally held horizontally over the body although it is sometimes held erect or stretched backwards. It is quiescent except for an occasional raising of the anterior portion of the body on its hinged posterior end. This generally happens when the pupa is disturbed, and its frequency increases as the time of metamorphosis to the adult approaches. The pupa is similar to the mature larva in appearance, being very flat, largely green and possessing the same “parasol,” though this structure is increased in size by the addition of the molted skin of the fifth instar larva, part of which, however, is beneath the pupa. The principal difference is the broad rounded pronotal shield and the flattened lateral extensions of the abdominal segments. The pupal stage averages a little more than five days in length, generally four days or barely over in the warm seasons (table II).

Adult: The adult emerges from the pupa by a splitting of the pupal exoskeleton across the pronotum near its anterior margin and along the median dorsal line of the thorax. The process of emergence takes about 15 minutes, and when this is completed the elytra are fully formed but the beetle is white in color. During the following several hours it gradually takes on its natural coloration, though it does not display its normal shining appearance of burnished gold for three to six days or more, and until it has been exposed to sunshine. During this period the adults are fairly quiescent, but toward its close feeding commences. Mating was first observed to take place six days after emergence. The life of reared adults averaged 121 days, with the greatest length 285 days for males and 371 days for females.

Mating is continued at frequent intervals and lasts for long periods, although much of the time the female moves about and even feeds with the male simply riding on her back, the copulating organs retracted. During the first several days these activities may occupy a considerable portion of the time.

The earliest recorded egg-laying took place five days after the first observed mating, and 11 days after metamorphosis to the adult stage. Egg cases are constructed daily, or almost daily, henceforth, generally until a day or two before the death of the female, and number from one to eight, or possibly more, per day. The length of the egg-laying period varies from a few weeks up to nearly a year. For 13 recorded females the egg-laying period varied from 20 to 356 days, and the average was 79.2 days. The number of eggs laid by a single female may well exceed one thousand.

In the case of the egg-laying record of one female, eggs were laid for 118 days, from June 10 to October 5, 1942. A total of 324.5 oothecae were constructed, an average of 2.75 per day. The oothecae contained an average of 1.87 eggs each.

From eight selected reared females, four mated in August, two in September, one in November, and one in June, the following information was obtained on oviposition: The average length of the egg-laying period was ten weeks, the extremes nine and sixteen weeks. The average number of egg cases laid was 128, or 1.7 per day. The total number of egg cases laid per individual varied from 63 to 228. The average number laid per day varied from 1.1 to 3. The maximum per day varied from 3 to 7 for the different individuals, the average maximum being 4. The average numbers of egg cases per female per week for the first eight weeks (eight females) were as follows: 11 oothecae; 9.9; 10.5; 10.5; 12.4; 16.6; 13.9; 15.2. In the ninth week (seven females) the average was 16.1; in the tenth week (four females) the average was 15.0; in the eleventh week (three females) the average was 14.3 oothecae. The maximum number of oothecae laid in one week was 38. From the figures for the average number of eggs laid in the first to eleventh weeks of the egg-laying periods of these females, it cannot be judged for certain whether the number of eggs laid per week increases toward, and past, the middle of the life of the female, or whether more eggs are laid in the fall, or in cooler weather, since most of the groups recorded commenced laying in August.

DESCRIPTION OF STAGES

Egg: (Plate 31, figure 1) Pale yellowish cream color. Slender, elliptical, dorsoventrally compressed, subacute at each end.

First instar larva: (Plate 31, figure 3) Pale greenish white to pale testaceous; body surface fairly transparent; spines whitish testaceous. Head flattened and subrounded, with a row of five small round black ocelli, one of which is out of line, on each side. Body broadly oval, moderately flattened dorso-ventrally and edged along each side with 16 tapering fleshy spines, each bearing several hairlike spinules along its sides and a long one at its apex. In addition to these, there is a caudal furca extending from dorsal surface of the penultimate abdominal segment. Its arms are longer than the body in newly hatched larvae and nearly as long as the body in larvae ready to molt. They are sinuate in the form of a lyre and each bears several oblique spinules externally. Sometimes feces are borne on the furca. The anus is a long fleshy cylinder capable of being telescoped.

Second instar larva: (Plate 31, figure 4) Very similar to first instar except for presence of molted skin of latter on caudal furca in the form of a transverse structure formed of two obliquely placed oval forms fringed externally by shorter body spines, said structure preceded by molted skin of head-capsule bordered by longer body spines with caudal furca projecting from distal end. Spiracles visible as small colorless erect cylinders on sides of dorsum.

Third instar larva: (Plate 31, figure 5; plate 36, figure 7) Pale testaceous, sometimes tinged with greenish. Similar to second instar except for additions to "parasol" of molted skin of latter, same as that of first instar except for larger size. Head capsule tending to be partly hidden by folding under pronotum both during feeding and rest.

Fourth instar larva: (Plate 31, figure 6) Greener than the preceding and having the molted skin of the latter added to the caudal appendage.

Fifth instar larva: (Plate 31, figure 7; plate 32, figure 1) Broadly ovate, dorsoventrally compressed; lateral margins with long spine-bearing processes; caudal furcae bearing four sets of exuviae, each united to the next by the respective furcal shells, the entire structure held horizontally over the body, or at times tilted upward or backward, reaching to or beyond anterior end of body. Head not visible from above. Prothorax nearly one-half as long as broad (excluding processes), slightly emarginate at middle of anterior margin, bearing three long, tapering-cylindrical, translucent, almost colorless processes on each side, each about as long as one-half transverse width of segment and bearing numerous pitchy, pale-based spines; disc with a pair of submedian rows of small pitchy spines, and a large, irregular blackish crescent-shaped area on each side, slightly convex, and more distinctly defined posteriorly; first spiracle just anterior to posterior margin, near side, its opening consisting of a small blackish ring. Mesothorax four times as broad as long, bearing three processes at each side, similar to those of prothorax; disc with a very few brownish hairlike spines on central portion. Metathorax very similar to mesothorax, slightly broader laterally, with two processes at each side. First abdominal segment widest in middle, bearing at each side a single large process similar to those of thorax and a slightly raised cylindrical dark-edged spiracle on dorsal surface near anterior border some distance in from the external margin; the following segments similar but with spiracles gradually smaller and closer to external margin, spines of sixth and seventh segments longer than the others, those of fourth shortest.

Pupa: (Plate 32, figures 2–3) Body largely green or pale green with expanded portions of thorax and abdomen transparent and colorless, those of latter pitchy at tips; eyes black; mandibles and tarsal claws reddish to pitchy black; an oblong area around each spiracle and a narrow transverse line extending mediad near posterior margin of each respective segment testaceous brown to pitchy; ''parasol'' dirty testaceous. Coloration darker as metamorphosis approaches, except for general green color of body, which fades to pale cream color. Head well retracted beneath pronotum, broadly fused to thorax; antennae and legs sunken in surrounding areas, forming a fairly smooth ventral surface; pronotum broader than rest of body, twice as broad as long, somewhat evenly rounded along margin and bordered with about 22 or 23 pairs of small fleshy spines, the fourth and eighth or thereabouts from the middle on each side about twice as large as others; discal surfaces of thorax smooth; first five abdominal segments each bearing at either side a broad tapering strongly acuminate lateral process with slender marginal spinules and an erect cylindrical spiracle slightly inward from lateral margin of tergum. Caudal end of abdomen attached to leaf by means of molted skin of fifth instar larva, with spines of latter forming a broad radiating fringe.

Adult: (Plate 32, figure 4) In life brilliant iridescent yellowish golden on pronotum and elytral discs and bases of expanded elytral margins (sometimes these parts are rich iridescent purplish or blackish brown); remainder of dorsal surfaces transparent and golden amber colored; dried specimens with pronotum, elytral discs and bases of expanded elytral margins amber colored to pitchy red, head pitchy to black and ventral surfaces and appendages reddish testaceous. Head imbedded in prosternum, slightly deeper than wide, less than one-fifth as broad as prothorax; antennae slender, slightly thicker distally, reaching very little beyond outer edges of prothorax; prothorax nearly twice as broad as long, its anterior margin evenly rounded and surfaces smooth and glossy; scutellum triangular; elytra rounded, together with prothorax nearly forming a circle, disc of each swollen at humerus and on suture behind scutellum, forming a common tubercle, and also finely punctured in about nine incomplete longitudinal rows; explanate margins smooth; legs short; femora falling far short of reaching borders of expanded margins. Table III presents the range of measurements for the various life stages. First instar larva is represented by L_1, second instar by L_2, etc.

TABLE III

Measurements of various stages of *Aspidomorpha furcata* in millimeters

	Length of body excluding spines	Width of body including spines	Width of body excluding spines	Breadth of head-capsule
Egg	1.2 –1.35	....	.58– .62	....
Newly hatched larva	1.2 –1.4	1.0–1.2	.50– .60	.31– .42
Mature L_1 (first instar)	1.7 –2.0	1.4–1.7	.80– .88	
New L_2	1.7 –1.8	1.7–1.8	.80–1.0	.40– .52
Mature L_2	1.98–2.4	1.8–2.2	1.02–1.5	
New L_3	2.0 –2.4	2.1–2.4	.98–1.5	.54– .73
Mature L_3	2.4 –3.12	2.4–3.0	1.35–1.45	
New L_4	3.1 –3.3	3.0–3.2	1.8 –1.86	.74– .88
Mature L_4	4.0 –5.0	3.7–4.0	2.04–2.4	
New L_5	5.0 –5.4	4.8–5.3	1.5 –1.8	.87–1.4
Mature L_5	5.7 –6.5	5.8–6.2	3.6 –3.75	
Pupa	6.5 –6.6	5.5–6.5	5.0 –6.0	1.2 –1.4
Adult	6.6 –8.8	....	5.5 –7.2	.9 –1.05

PARASITES AND PREDATORS

At least one chalcidoid parasite (plate 31, figure 8) of the larva, probably belonging to the Encyrtidae, has been reared, and possibly others also occur locally. A minute hymenopterous egg-parasite has also been found at Canton. The pupa and adult of this species each measures about 1.2 mm. in length, and the adult emerges by boring a hole through the ootheca to the outside.

Both of these species may attain a parasitism of as much as 15 per cent or more at times, and are therefore of some importance in keeping down the numbers of the host. The adult beetles may occasionally be killed by parasitic fungi. The larvae, pupae, and adults are preyed upon by some of the smaller insectivorous birds such as tits, flycatchers, wagtails, and wren-warblers, and probably also by lizards.

Control: Handpicking of egg cases, larvae, pupae, and adults is tedious and time consuming, but may be the most practicable method for local farmers under existing conditions. It is important to pick extensively and thoroughly early in the spring before the population has increased with the first spring generations. Attention must not only be paid to sweet potato and swamp cabbage, however, for the populations may be maintained and increased on morning glory, and these plants must either be exterminated or the insects likewise controlled on them.

Chemical control should prove effective if carried out over a large enough area, and if the wild hosts be treated as well as the cultivated ones. Derris (rotenone) is effective for spraying, as are solutions of lead arsenate. Miller (1935) experimented successfully with Derris on *Aspidomorpha miliaris* in Malaya by using 75 grams of fresh root dried and added to 1,000 cc. of water. Derris may also be dusted on the plants. Lever (1934) suggested two pounds of lead arsenate to 50 gallons of water for *Aspidomorpha australasiae* var. *guerini* in the Solomon Islands. Hutson (1929) recommended super-arsenate of lead at rate of one pound to 50 gallons of water for *Aspidomorpha furcata* in Ceylon.

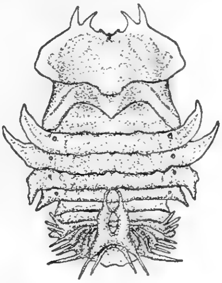
Biological Data on Other Chinese Species

Basiprionota bimaculata (Thunberg)

(Text figure 1)

A number of larvae were reared on *Premna,* and one on *Liquidambar* at Suisapa, Lichuan, Hupeh Province, in July and August. The mature larva is about 8 mm. long, largely dark greenish with the pronotal disc and sides of the hind thorax darker; the lateral spines of the abdomen are pale; those of the thorax are dark, except that the first two are pale with darkened apices. The spines all bear very short spinules. The thoracic spines are of moderate length and subequal; the abdominal spines are stouter, the first three being about as long as the thoracic spines, the next three distinctly shorter and the last two by far the longest of all. The caudal furcae are stout, with slender, arched apices. The exuvial mass is compact, with the fecal mass above it extensive, consisting of crowded, arched filaments extending forward and often largely hiding the larva.

The pupa is yellowish with some darker markings on the back. It is broadest at middle. The pronotum is broadly expanded at sides and bears two stout, tapering, curved spines at each corner of anterior emargination, and a short pair near middle of emargination. The lateral lobes of the second to fourth abdominal segments are large, flat, tapering and briefly tuberculate. The first two bend forward and the third backward. The fifth and sixth segments each bear a small posteriorly directed process. The pupal stage lasted five days.



Text figure 1; *Basiprionota bimaculata*, pupa

Basiprionota chinensis (Fabricius)

Larvae, pupae and adults of this species were found together on the same plant at Behluhdin, Szechuan Province, on August 21, 1940. The host was a large-leaved herb about eight feet tall, but was not identified.

Craspedonta leayana insulana (Gressitt)

Numerous larvae, pupae and adults were found at Ta-hian, Hainan Island in June, 1935. The host was a small tree, probably *Gmelina*, the host of the typical form in Burma. The larva is stout, bearing long tapering cylindrical processes. The fecal mass consists of long irregular spreading filaments. The mature larva is blackish brown and the pupa is yellow with black markings. The pupa bears a pair of long tapering processes on each side of front of prothorax and similar ones on sides of abdominal segments.

Aspidomorpha sanctae-crucis (Fabricius)

(Plate 36, figure 3; pupa)

The larva has the four anterior prothoracic spines of each side long, the remainder of the lateral spines slightly shorter, except the last pair, and all with fairly long slender spinules. The fecal mass carried by the larva consists of long slender filaments, rather loosely arranged. The pupa has the pronotum even in anterior margin, with many minute marginal processes. The lateral processes of the abdominal segments are broad, flat and tapering and acute, with moderate spinules.

Laccoptera quadrimaculata (Thunberg)

(Plate 35; plate 36, figures 5 and 8)

This species feeds on the same host plants at Canton as does *Aspidomorpha furcata* (Thunberg), and is about equally common and destructive, if not more so. It is somewhat larger in bulk than the latter, being much more strongly convex and nearly as large in diameter. The ootheca consists of one to six or seven eggs laid horizontally in a compact mass embedded in translucent orange material and topped off with a small mass of black feces. The larva is orange at hatching and gradually becomes browner with the five successive instars. Its ''parasol'' consists of the exuviae fitted more closely together than in *A. furcata* and matted with a solid mass of feces which nearly hides the exuviae. The egg-laying record for a female was kept for the entire course of her life, from July 11 to October 3, 1942. She first mated on July 8. She laid a total of 972 eggs, an average of 11.6 eggs per day. The egg-laying record of another female was recorded from June 15 to August 17, 1942. She belonged to a mating pair collected in the field on May 29. The pair were observed mating again on June 8, and oviposition commenced on June 15. The female laid 768 eggs, an average of 12 per day. Of these eggs, 417 were laid in 218 oothecae, or an average of 1.9 eggs per ootheca. Both the male and female died on August 17, and eggs were laid up to and including that day. (See Hoffmann, 1933, and Kershaw & Muir, 1907.)

Cassida (Taiwania) circumdata Herbst

(Plate 28, figure 2; plate 36, figures 6 and 9)

This species is also very common on various species of *Ipomoea,* including sweet potato, at Canton, and is therefore likewise a pest. The eggs are laid singly in transparent capsules of a greenish or brownish color. The larvae and pupae are green. They resemble those of *Aspidomorpha furcata* in general form, but are easily distinguishable, as shown in the keys, below. The feces are not extruded on the exuviae in long strands, but are attached in small masses at the tips of the caudal furcae. The life history of this species has already been reported upon (Yeung, 1934). Plate 10, figure 9, illustrates a parasite of the larva.

Cassida (Taiwania) obtusata Boheman

(Plate 34)

This species is common at Canton, and is brilliant golden in the adult stage. It feeds in the larval and adult stages on cockscomb *(Celosia argentea* Linn.) and on *C. cristata, Amaranthus tricolor, A. paniculatus, Alternanthera sessilis,* and *Spinacia oleracea* at Canton. The adults are also minor pests of various species of *Citrus, (C. maxima, C. limonia, C. nobilis, C.*

sinensis) particularly orange and pomelo, and also *Fortunella margarita,* feeding on the young leaves in various seasons, but particularly in the winter and early spring. The larvae, however, could not be induced to feed on even very tender *Citrus* leaves. Table IV shows the lengths in days of the various stages of several individuals reared in the spring and early summer. Table V shows the dates and lengths of the generations of descendants of female no. G41–317, from August, 1941, to July, 1942. Five, however, is not necessarily the maximum number of generations per year, as the earliest eggs were not reared in every case. Since the life cycle occupies less than one month during the warm three-quarters of the year, as many as ten or twelve generations are possible.

One female, mated in September, laid 1,192 eggs in 11 weeks, or an average of nearly 16 eggs per day.

The molting of a larva of *C. obtusata* from the first to the second instar was observed on April 15, 1942. The molting process took place between 10:35 and 10:50 a. m. During the first 12 minutes the body contracted and expanded through muscular action and pressure of the body fluid in various parts. During this period the contractions and expansions increased in severity till the cuticle split along the mid-dorsal line, starting anteriorly, with the concentration of the body fluids there, and consequent swelling. The actual emergence occupied but three minutes. The larva was held to the leaf surface by the tarsal claws of the old cuticle until the new instar emerged and began using its legs. The final extrication from the exuviae was completed suddenly by the anterior portion of the body, the six legs all appearing at once. The exuvial legs remained attached until the abdomen was free except for its apex. Then as the larva placed its legs on the leaf surface the exuviae were snapped into the air and attached to the new caudal furca. The moulting was then complete and the exuviae shrank to their normal position in the "parasol" with the exuvial spines projecting.

TABLE IV

Length of immature stages of *Cassida obtusata* in days

No.	Date eggs laid	Length of egg stage	Larval stadia					Prepupa	Pupa	Egg to Adult	Adult	
			L_1	L_2	L_3	L_4	L_5				♂	♀
G42–2a	Apr. 4	3+	3.7	1.8	1.75	1.	5.	1.5	5.0	23.		
" d	"	5—	1.7	1.3	1.75	3.5	5.	1.5	5.0	24.7		
" g	"	5—	1.7	1.2	1.	4.	5.	1.5	5.0	24.5		
G42–6a	May 23	3	2.—	1.—	.6	.7	4.	2.	3.+	16.2		
" b	"	3	2.+	.7	.8	2.0	4.		3.0	15.5	30	
" d	"	3+	2.	.7	1.0	1.5	3.		3.—	14.2		54
" e	"	3+	2.	.7	.8	2.	3.		3.0	14.5	71	
" f	"	3+	1.7	.7	1.5	1.5	4.		3.0	15.5		76
G42–9a	June 22	3+	1.5	1.5	1.6	2.	4.2		3.8	17.7	63	
" b	"	3+	1.5	1.2	1.3	1.5	3.		3.5	15.1		

TABLE V

Generations of *Cassida obtusata* in one year

	Total days (egg to egg)
1. August 2–October 7, 1941	66
2. October 7–April 17, 1942	194
3. April 17–May 23, 1942	36
4. May 23–June 22, 1942	30
5. June 22–July 22, 1942	30

The feces are attached to the exuviae in a rather rough mass, largely obscuring them.

Cassida (s. str.) **japana** Baly

(Plate 33)

This species was reared on *Alternanthera sessilis* R. Br. at Canton. The eggs are laid individually in oblong, transversely striated, greenish oothecae. The larvae are not very different from those of *C. circumdata,* but are more slender, of a paler green, and have the spiracles much more prominent. They differ from those of *C. obtusata* in somewhat the same respects, those of the latter being much paler and shorter. The exuviae are more recognizable in the parasol than is the case in *C. obtusata.*

The life history occupies a very slightly longer period than is the case with *C. obtusata.*

The egg-laying record for the complete life of a female *C. japana* (No. G42–85) was as follows: The beetle emerged from the pupa on April 13, 1942, and was first observed to mate on April 25, when she was segregated with her mate. Egg-laying commenced on April 26 and continued to August 25, the female dying on August 28. Thus the egg-laying period lasted for 121 days. A total of 953 eggs were laid, representing an average of 7⅚ eggs per day. The maximum number of eggs laid in one day was 40, on May 29. During the first two weeks 139 eggs were laid, or an average of nearly 10 per day. During the first two weeks of June the average was 22 per day. Another female laid 777 eggs in ten weeks, or an average of 11 eggs per day.

In June the various stages lasted as follows: egg, 6 days; first instar larva, 2 days; second instar, 2 days; third instar, 2 days; fourth instar, 2 days; fifth instar, 5 days; pupa, 4 days; adult female 175 days (emerged in July). Another adult female lived for 105 days (emerged in October). In February the lengths of the stages were: egg, 13 days; first instar, 4 days; second instar, 5 days; third instar, 4 days; fourth instar, 5 days; fifth instar, 15 days; pupa, 11 days; adult female, 101 days.

KEY TO THE KNOWN OOTHECAE OF CHINESE CASSIDINAE

1. Oothecae composed of several or many thin, oblong, papery layers fastened at one end; the eggs hidden between them. *(Aspidomorpha)*.................... 2

— Oothecae not composed of many thin papery layers fastened at one end 4

2.(1) Oothecae of thin papery layers projecting at sides throughout.................. 3

— Oothecae with papery layers of egg-containing portion folded at sides to form air cells; each ootheca containing 32–80 eggs in 4 rows with 2 rows of air cells on each side of egg cells..*Aspidomorpha miliaris*

3.(2) Oothecae rather flat, generally containing 2–9 eggs......*Aspidomorpha furcata*

— Oothecae rather thick, generally containing a few dozen eggs each..*Aspidomorpha sanctae-crucis*

4.(1) Eggs laid singly or in small groups, generally with a thin covering layer or envelope, and often covered with feces in addition.. 5

— Eggs laid in a large dense group in a single layer, surrounded by a frothy mass which hardens to form a protective ootheca............*Craspedonta leayana*

5.(4) Eggs laid in small, rather evenly bordered capsules between 2 simple membranes without feces, or in groups covered with fecal masses.................... 6

— Eggs laid singly between 2 irregular layers of semi-transparent material covered with an irregular opaque layer with bars or undulations, which in turn is generally partly covered with bits of feces........................*Basiprionota*

6.(5) Eggs laid in small, sometimes individual, more or less transparent envelopes, generally without a thick covering of feces.. 7

— Eggs laid in small groups, often 1 or 2 on top of 2–4 in a transparent orange jelly-like material and more or less covered with a thick mass of feces...*Laccoptera quadrimaculata*

7.(6) Eggs not fringed with spicules.. 8

— Eggs fringed with small spicules, laid singly and covered with a translucent membrane ....*Sindia*

8.(7) Ootheca covered, or partly covered, by feces; 3–15 eggs, in 3 layers, per ootheca 9

— Ootheca without any fecal covering; 1–2 eggs per ootheca.......................... 10

9.(8) Egg with chorion reticulate and micropyle not easily recognizable..*Cassida* (s. str.) *nebulosa*

— Egg with chorion not reticulate; micropyle distinct, consisting of a small plate with radiating impressions.....................*Cassida (Odontionycha) viridis*

10.(8) Eggs laid between 2 semi-transparent brownish membranes of oval or oblong outline, with corrugations transverse or lacking.. 11

— Eggs laid singly in a subtransparent green, or less often brownish, capsule shaped like the vane of an arrow, with oblique corrugations from the bicarinate median ridge...*Cassida (Taiwania) circumdata*

11.(10) Ootheca oblong, with transverse corrugations; containing a single egg...*Cassida* (s. str.) *japana*

— Ootheca irregularly oval, lacking corrugations; generally 2 eggs per ootheca..*Cassida (Taiwania) obtusata*

KEY TO THE KNOWN MATURE LARVAE OF CHINESE CASSIDINAE

1. Second lateral process of mesothorax and anterior lateral process of metathorax shorter than posterior processes of same segments, or lacking.... 2

— Second lateral process of mesothorax and anterior lateral process of metathorax of more or less equal length; 16 pairs of lateral processes exclusive of caudal furcae 6

2.(1) Second lateral process of mesothorax and anterior lateral process of metathorax lacking or minute; 14 pairs of lateral processes excluding caudal furcae; feces arranged in long stringy filaments.... 3

— Second lateral process of mesothorax and anterior lateral process of metathorax somewhat shorter than posterior processes of same segments; 16 pairs of lateral processes 4

3.(2) Anterior 2 pairs of processes of pronotum fully as long as lateral processes, nearly as long as last 2 abdominal pairs; dorsal surfaces dull and evenly pigmented except on sides of pronotum, which are pale.... *Craspedonta leayana insulana*

— Anterior 2 pairs of processes of pronotum shorter and stouter than most of lateral processes, much shorter than last 2 abdominal pairs; dorsum with many dark spots on paler ground color.... *Epistictia*

4.(2) Lateral processes more or less stout, with granule-like spinules; feces attached to sides of exuviae in long curved filaments in concentric arcs.... 5

— Lateral processes long, slender and rigid, with slender spinules; feces not in long curved filaments.... *Hypocassida subferruginea**

5.(4) Lateral processes not very stout.... *Basiprionota bimaculata*

— Lateral processes thick, short and fleshy.... *Basiprionota maculipennis reducta*

6.(1) Lateral processes generally longer than ¼ width of body, or caudal furcae at most hardly more than twice as long as last pair of lateral processes; length of mature larva generally over 7 mm.... 7

— Lateral processes generally shorter than ¼ width of body, or caudal furcae much more than twice as long as last pair of lateral processes; length of mature larvae generally under 7 mm.... 13

7.(6) First 2 processes on each side of prothorax distinctly joined at bases, bearing stout spinules; caudal furcae fully twice as long as last pair of lateral processes 8

— First 2 processes on each side of prothorax not very distinctly joined at bases, bearing slender spinules; caudal furcae not twice as long as last pair of lateral processes.... 9

8.(7) "Parasol" forming a triangle which is somewhat longer than broad.... *Sindia*

— "Parasol" forming a triangle which is broader than long.... *Laccoptera quadrimaculata*

9.(7) Feces generally not of extremely long slender filaments, or not retained long on exuviae 10

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* This genus and species have not been recorded from China, but may occur in northern Sinkiang or Mongolia, since it has a widespread Palearctic distribution.

— Feces of very long slender filaments which are fairly persistent; fifteenth and sixteenth lateral processes much longer than fourteenth...*Aspidomorpha sanctae-crucis*

10.(9) Caudal furcae much longer than last pair of lateral processes...................... 11

— Caudal furcae not longer, or barely longer, than lateral processes............ 12

11.(10) Caudal furcae irregularly sinuate; spinules mostly longer than subbasal diameters of lateral processes; dark pigment only on sides of pronotum and bases of caudal furcae..*Aspidomorpha chandrika*

— Caudal furcae regularly sinuate; spinules mostly shorter than subbasal diameters of lateral processes; bases of lateral processes and 2 spots on each side of each abdominal tergite black...................................*Aspidomorpha dorsata*

12.(10) Lateral processes pale, enlarged at extreme bases; spinules abundant on distal portions of processes; dorsum pale green except for sides of pronotum ....*Aspidomorpha furcata*

— Lateral processes black, not enlarged basally; spinules few and short on distal portions of processes; dorsum creamy marked with pairs or transverse rows of black spots..*Aspidomorpha miliaris*

13.(6) Caudal furcae more than twice as long as fifteenth lateral process.......... 14

— Caudal furcae not more than twice as long as fifteenth lateral process.... 15

14.(13) Caudal furcae 2 or 3 times as long as fifteenth or sixteenth lateral processes; length of spinules not as great as subbasal diameters of processes in all cases; generally feeds on Labiatae...................*Cassida (Odontionycha) viridis*

— Caudal furcae about 4 times as long as fifteenth or sixteenth lateral processes; length of spinules greater than subbasal diameters of lateral processes in most cases; generally feeds on Chenopodiaceae.........*Cassida* (s. str.) *nebulosa*

15.(13) Feces rather densely matted on exuviae; fifteenth and sixteenth lateral processes fairly equal in length, or body length under 5 mm........................ 16

— Feces sparse or limited to caudal furca of first instar exuviae; fifteenth and sixteenth lateral processes unequal in length, or spinules perpendicular to lateral processes 17

16.(15) Exuviae hidden by feces, making determination of instar difficult; length of body less than 5 mm.; generally feeds on Amaranthaceae as larva and on *Citrus* as adult...*Cassida (Taiwania) obtusata*

— Exuviae not hidden by feces, visible from above in resting position; length about 8–9 mm.; generally feeds on Compositae.......*Cassida* (s. str.) *rubiginosa*

17.(15) Fifteenth lateral process more than twice as long as fourteenth; fifteenth and sixteenth lateral processes of each set of exuviae prominently projecting at sides; caudal furcae of first instar exuviae long, widely divergent and bearing a solid feces mass; feeds on Convolvulaceae...*Cassida (Taiwania) circumdata*

— Fifteenth lateral process not much longer than fourteenth; fifteenth and sixteenth lateral processes of each set of exuviae not prominently projecting; caudal furcae of first instar exuviae not long and widely divergent; feeds on Compositae, Chenopodiaceae, and Amaranthaceae....*Cassida* (s. str.) *japana*

KEY TO THE KNOWN PUPAE OF CHINESE CASSIDINAE

1. Pronotum at least slightly emarginate apically in middle, or with a few long projecting processes 2
— Pronotum not emarginate apically, or only very narrowly emarginate at middle of anterior border and fringed with many small processes 4

2.(1) Pronotum feebly emarginate apically, with 2 forward projecting processes on each side of anterior border 3
— Pronotum tuberculate on disc, distinctly emarginate apically, with 2 short, stout, incurved processes on each side of emargination; abdomen with stout fleshy lateral processes on second to fourth segments .... *Basiprionota bimaculata*

3.(2) Abdomen with a long, curved process on each side of first 5 segments; dorsum marked with large areas of dark and pale .... *Craspedonta leayana insulana*
— Abdomen with a stout triangular process on each side of first 5 segments; dorsum marked with transverse or arcuate bands of black spots .... *Epistictia*

4.(1) Anterior margin of pronotum with many small, slender processes 5
— Anterior margin of pronotum with only 2 processes on each side of middle; lateral expansions of abdominal segments with very short spinules; dorsum marked with a pair of oblong black spots on each of the first 2 abdominal segments .... *Aspidomorpha miliaris*

5.(4) Abdomen with third and fourth spiracles not 3 times as high as first and second 6
— Abdomen with third and fourth spiracles 3 times as high as first and second; lateral expansions of intermediate abdominal segments parallel-sided basally, with 4–6 spinules on each side of each .... *Cassida* (s. str.) *nebulosa*

6.(5) More than 5 spinules on posterior margin of each lateral abdominal process 7
— Generally only 2–4 spinules on posterior margin of each lateral abdominal process 10

7.(6) Lateral abdominal processes gradually narrowed, slender and acuminate distally; prothorax nearly twice as broad as long 8
— Lateral abdominal processes suddenly narrowed distally; prothorax much less than twice as broad as long, bordered by about 75 spinules of appreciable length .... *Laccoptera quadrimaculata*

8.(7) Pronotum entirely pale; lateral abdominal processes entirely or largely pale; spinules of pronotal margin of appreciable length 9
— Pronotum black along base and on median portion almost to anterior margin; spinules of pronotal margin extremely short; first pair of lateral abdominal processes dark; length 15 mm .... *Aspidomorpha sanctae-crucis*

9.(8) Abdominal terga largely dark brown; lateral abdominal processes bordered anteriorly with brown, and with minute spinules; length 11 mm .... *Aspidomorpha dorsata*
— Abdominal terga brown along a lateral strip passing over spiracles; lateral

abdominal processes entirely pale, with spinules fully one-half as long as those of pronotal margin; length 6–7 mm……*Aspidomorpha furcata*

10.(6) Anterior margin of pronotum lacking 1 or 2 pairs of spinules which are much thicker than others near middle of margin…… 11

— Anterior margin of pronotum with 1 or 2 pairs of spinules which are much thicker than others near middle of margin…… 12

11.(10) Sides of pronotum angulate near middle; anterior margin narrowly emarginate at middle……*Cassida* (s. str.) *rubiginosa*

— Sides of pronotum evenly rounded; anterior margin not emarginate……*Cassida (Taiwania) circumdata*

12.(10) Posterolateral corners of prothorax rounded, or at least not produced…… 13

— Posterolateral corners of prothorax angulate and produced posteriorly; lateral expansions of third to fifth abdominal segments very short……*Cassida (Odontionycha) viridis*

13.(12) Anterior spiracles of abdomen several times as high as wide; color grass green; length 4.75 mm……*Cassida* (s. str.) *japana*

— Anterior spiracles of abdominal segments not several times as high as wide; color yellowish green to yellow; length 4 mm……*Cassida (Taiwania) obtusata*

HOST-PLANT RELATIONSHIPS†

A study of the host-plant relationships of the Cassidinae of the world has been made as an aid in drawing conclusions as to the derivation and evolution of the Chinese fauna in this group. All available and reliable sources in the literature have been taken into account, though only specific larval food plants are considered. Collection records of adult beetles are by no means reliable indications of larval food plants, or even of adult food plants unless it be recorded that the adults were actually observed to be feeding on the particular plant.

Following is a list of plant families fed upon by tortoise beetles, with each plant family followed by the names of the genera of beetles which definitely feed upon its members in the larval stage. Fifty genera of tortoise beetles are involved, and in addition, six subgenera of the genus *Cassida*. Both plant families and beetle genera are arranged phylogenetically. Members of the genera asterisked attack more than one plant family.

Palmaceae: Platyauchenia, Hemisphaerota, Delocrania, Spaethiella.

Urticaceae: *Cassida (*Cassidulella).

Chenopodiaceae: Oxylepis, Ischyronota, *Cassida (*Cassida, *Mionycha, *Cassidulella).

Amaranthaceae: *Cassida (*Cassida, *Taiwania).

Caryophyllaceae: *Cassida (*Odontionycha, *Cassida, *Mionycha, *Cassidulella).

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† This section was not revised after the manuscript was originally submitted in 1945.

Rosaceae: *Cassida (*Cassida, *Taiwania).

Euphorbiaceae: *Aspidomorpha (needs verification).

Sterculiaceae: Spaethiella, *Omaspides.

Asclepidaceae: *Chelymorpha, *Cassida (*Cassida).

Convolvulaceae: *Craspedonta, *Pseudomesomphalia, Neomphalia, *Poecilaspis, Selenis, Echoma, *Omaspides, *Chelymorpha, *Aspidomorpha, Sindia, Laccoptera, Agroiconota, Philaspis, Deloyala, *Coptocycla, Strongylaspis, *Plagiometriona, *Metriona, Cteisella, Ctenochira, Jonthonota, Oocassida, *Thlaspida, Hypocassida, *Cassida (*Cassida, *Taiwania).

Boraginaceae: Oma, Desmonota, *Polychalca, *Poecilaspis, Eurypepla, *Physonota, Cistudinella, Ischyrosonyx, *Coptocycla, Psalidonota, *Charidotis.

Solanaceae: Conchyloctenia, Gratiana, Orectis, *Plagiometriona, *Metriona.

Verbenaceae: *Craspedonta, Basiprionota, *Aspidomorpha, *Thlaspida.

Labiatae: Nebroma, *Polychalca, *Cassida (*Odontionycha, Lordiconia, *Cassida, *Mionycha).

Scrophulariaceae: *Physonota, *Cassida (*Cassida).

Bignoniaceae: Dorynota, Syngambria, *Charidotis.

Rubiaceae: *Charidotis.

Cucurbitaceae: *Pseudomesomphalia.

Compositae: *Pseudomesomphalia, Nebraspis, *Physonota, Basipta, Pilemostoma, *Cassida (*Odontionycha, *Cassida, *Mionycha, *Cassidulella).

In the following list the host-plant families and genera are listed for each zoogeographical region. The numbers of tortoise-beetle genera and species attacking each follow in parentheses, except for families attacked in more than one region, which are asterisked. In this list beetle subgenera are counted as genera. One hundred and fifty-eight species of the fifty-five genera or subgenera are involved. The plant families are arranged approximately in systematic order, principally following the Engler-Prantl system.

Palearctic Region

Urticales: Urticaceae (1 genus: 2 species of beetles)—Urtica (1:2).

Centrospermae: Chenopodiaceae (4:6)—Beta (2:4), Chenopodium (2:3), Atriplex (3:4), Salicornia (2:3), Salsola (2:2). Caryophyllaceae (4:8)—Stellaria (2:2), Arenaria (2:3), Spergula (3:5), Lychnis (1:1), Saponaria (1:3), Silene (4:5), Dianthus (2:3).

Rosales: Rosaceae (1:1)—Pyrus (1:1), Prunus (1:1), Sorbus (1:1).

Gentianales: *Asclepidaceae—Cynanchum (1:1).

Polemoniales: *Convolvulaceae—Convolvulus (2:3), Calystegia (1:1) (the beetle species belongs to an Oriental genus).

Lamiales: *Verbenaceae—Callicarpa (1:1) (beetle genus is Oriental). *Labiatae—Nepeta (1:1), Salvia (3:4), Stachys (1:1), Lycopus (2:2), Mentha (2:2), Thymus (1:1), Melissa (1:1), Galeopsis (1:1).

Scrophulariales: *Scrophulariaceae—Verbascum (1:1).

Asterales: *Compositae—Cichorium (1:1), Scorzonera (1:3), Sonchus (1:2), Hieracium (1:1), Inula (3:3), Filago (1:1), Helichrysum (1:1), Antennaria (1:1), Anthemis (2:3), Achillea (2:9), Tanacetum (1:7), Matricaria (1:1), Artemisia (1:2), Senecio (1:1), Silybum (1:1), Cynara (1:1), Cirsium (2:6), Carduus (1:3), Centaurea (2:3), Serratula (1:1), Onopordon (1:2), Lappa (1:2), Fulicaria (1:3), Gnaphalium (2:2).

Nearctic Region

Princeps: *Palmaceae—Sabal (1 genus: 1 species of beetles).

Gentianales: *Asclepidaceae—Asclepias (1:1).

Polemoniales: *Convolvulaceae—Convolvulus (8:10), Ipomoea (4:7). *Boraginaceae—Cordia (2:2). *Solanaceae—Solanum (4:4), Lycopersicum (1:1), Capsicum (1:1), Physalis (3:3).

Scrophulariales: *Scrophulariaceae—Monarda (1:1).

Asterales: *Compositae—Helianthus (1:1), Silphium (1:1).

Neotropical Region

Princeps: *Palmaceae—Cocos (3 genera: 4 species of beetles).

Malvales: Sterculiaceae (2:2)—Theobroma (2:2).

Polemoniales: *Convolvulaceae — Ipomoea (12:25). *Boraginaceae—Cordia (7:9), Patagonula (3:3). *Solanaceae—Solanum (2:3), Acnistus (1:1), Physalis (1:1), Bassowia (1:1).

Lamiales: *Labiatae—Hyptis (2:2).

Scrophulariales: Bignoniaceae (3:10) — Tecoma (2:5), Pyrostegia (1:2), Bignonia (1:1), Pithecoctenium (1:1), Arrabidaea (1:1).

Rubiales: Rubiaceae (1:1)—Anisomeris (1:1).

Cucurbitales: Cucurbitaceae (1:1)—Cucurbita (1:1).

Asterales: *Compositae—Eupatorium (1:1), Baccharis (1:1), Mikania (2:3).

Ethiopian Region

Polemoniales: *Convolvulaceae — Ipomoea (2 genera: 4 species of beetles). *Solanaceae—Solanum (2:2).

Asterales: *Compositae—Brachylaena (2:2).

Oriental Region

Centrospermae: Amaranthaceae (1 genus: 3 species of beetles)—Celosia (1:1), Amaranthus (1:2), Alternanthera (1:1).

Polemoniales: *Convolvulaceae—Convolvulus (1:1), Ipomoea (8:16), Calonyction (1:1), Rivea (1:1).

Lamiales: *Verbenaceae—Callicarpa (1:1), Gmelina (2:2), Premna (1:3), Tectona (1:1).

Following are the total numbers of genera and species of tortoise beetles attacking members of the 14 plant families mentioned above, for the world: Palmaceae (3 genera: 5 species of beetles), Urticaceae (1:2), Chenopodiaceae (4:6), Amaranthaceae (1:3), Caryophyllaceae (4:8), Rosaceae (1:1), Sterculiaceae (2:2), Asclepidaceae (2:2), Convolvulaceae (22:58), Boraginaceae (9:12), Solanaceae (6:11), Verbenaceae (4:7), Labiatae (6:8), Scrophulariaceae (2:2), Bignoniaceae (3:10), Rubiaceae (1:1), Cucurbitaceae (1:1), Compositae (9:28).

The above host records may be analyzed geographically as follows: In the Palearctic region hosts are known for 7 of the 12 genera of tortoise beetles, or 58 per cent (11 of the 18 genera and subgenera), and for 42 of the 102 species, or 42 per cent. In the Nearctic region hosts are known for 12 of the 15 genera, or 80 per cent, and for 18 of the 31 species, or 58 per cent. In the Neotropical region hosts are known for 29 of the 109 genera, or 27 per cent, and for 63 of the 1,663 species, or 4 per cent. In the Ethiopian region hosts are known for 4 of the 35 genera, or 12 per cent, and for 8 of the 649 species, or 1 per cent. In the Oriental region, hosts are known for 9 of the 27 genera, or 33 per cent, and for 27 of the 445 species, or 6 per cent.

The Cassidinae may be said to be rather limited in the range of their host-plant preferences, both in the sense of the subfamily as a whole, and as individual species. In Europe, where the beetles are best known, several species feed upon five or more genera of plants, though in such a case the plant genera usually are limited to one or two families.

Fourteen genera of tortoise beetles are recorded to attack members of more than one plant family each. Their names follow with the number of plant families listed in parentheses following each: Craspedonta (2), Polychalca (2), Pseudomesomphalia (3), Poecilaspis (2), Omaspides (2), Chelymorpha (2), Physonota (3), Aspidomorpha (3), Coptocycla (2), Plagiometriona (2), Metriona (2), Charidotis (3), Thlaspida (2), Cassida (10) [subgenera: Odontionycha (3), Cassida (9), Mionycha (4), Cassidulella (4), Taiwania (3)].

The largest number of plant families attacked by members of a single genus is ten. The genus, *Cassida,* is the best known of all as to its host relationships, and extensive records of nearly fifty species of the genus are represented among the ten host plant families. However, being an old and generalized genus, it very likely has the broadest host-preference range. For the entire world, the average number of host genera per beetle species is slightly under two, for those of known hosts, though for Europe it is close to three. The species with the largest number of host plant genera, *Cassida (Mionycha) margaritacea* Schaller, of Europe, feeds upon *Atriplex, Spergula, Saponaria, Silene, Dianthus, Thymus, Antennaria, Centaurea, Helichrysum, Gnaphalium,* and, perhaps questionably, *Clematis.* Thus it feeds upon members of four plant families, for certain. Next to this species two European species of the subgenus *Cassidulella* feed on eight or nine plant genera each. Forty-two European species feed on 52 plant genera. One hundred and fifty-eight world species attack 90 plant genera.

Perhaps the most striking fact to be gleaned from the above data is the great concentration on two plant families, the Convolvulaceae, attacked by 25 genera (and 2 subgenera of *Cassida),* and the Compositae, attacked by six genera (and 4 subgenera of *Cassida).* Furthermore, the European species *(Cassida)* largely attack the Chenopodiaceae, Caryophyllaceae, Labiatae, and Compositae, while the majority of the tropical species, both Paleotropical, and Neotropical, attack the Convolvulaceae. Plants belonging to the latter family are fed upon by 40 per cent of the beetles of known host relationship. The Compositae are attacked by 18 per cent, and the Bignoniaceae by 8 per cent, the latter being all Neotropical.

Analyzing the plant hosts, it will be seen that only 18 out of the 200 most important higher plant families are attacked, and only one of the families is monocotyledonous, all being angiosperms. Furthermore, only ten out of 45 major divisions of the Angiospermae are concerned. Sixty-seven per cent of the tortoise-beetle species attack members of the group Tubiflorae, and 18 per cent those of the Campanulariae. Nine per cent attack members of the Centrospermae and 10 per cent attack the other seven groups, there being a 4 per cent overlapping in plant group preference. Further, analyzing geographically, the Palearctic beetles nearly all attack the Campanulariae and Centrospermae, the Oriental and Nearctic species largely attack the Tubiflorae, and the Neotropical and Ethiopian species largely attack the Tubiflorae and Campanulariae.

As far as the phylogeny of the plant hosts is concerned, it may be seen that the most primitive tortoise beetles attack the most primitive plants and the most advanced forms concentrate on the most advanced plants, though having a wider host preference range. Furthermore, the sympetalous plants (above the Sterculiaceae), which are so particularly attacked, are, according to one theory (Bessey, 1915), supposed to have been derived from the particular groups of choripetalous plants which serve as the hosts of the remainder of the subfamily, exclusive of those feeding on Palmaceae.

These facts, correlated with the history of these plant groups, as it becomes better known, may serve as an aid in the study of the phylogeny of the Cassidinae. From the data accumulated, it is obvious that the tortoise beetles have, in the main, relatively narrow host preferences, and have probably not changed them much during their course of evolution, since the same genera of plants are concentrated upon in the Paleo- and Neotropical parts of the world, and species occurring both in Europe and Japan feed upon approximately the same plants. Thus the evolution of the Cassidinae is at least to some extent associated with the evolution of the higher sympetalous plants.

ZOOGEOGRAPHY †

The Cassidinae lend themselves well to a study of distribution of life, since they are rarely transported from one area to another by man, other forms of life, or the elements. Thus their present world distribution, excepting one or two European species introduced into North America, may be considered to be a result of the combined effects of their own evolution, the evolution and dissemination of their plant hosts, and the movements in the earth's crust since late Paleozoic time.

The most striking facts of the world distribution of the tortoise beetles at the present time are that the group is dominantly Neotropical, having over one-half its known species in that region, and that it is practically lacking from the Nearctic and Australian (Oceanic) regions. In table VI the major zoogeographical regions or subregions of the world are listed with the numbers of genera and species of Cassidinae known from each. The extent of generic and specific endemism is also indicated for each. Thus it is seen that no species, or even genera, are possessed in common by the Old and New Worlds, that no species occur on the Pacific islands north and east of the Solomons and New Caledonia, and that very few species overlap the regions or subregions listed. It may further be added that the Nearctic species, or those so listed, are actually largely confined to the southern areas of North America which are considered to be essentially Neotropical in the origin of their faunae. This is even more significant since it appears that no fossil Cassidinae are known from North America, where most beetle groups of Holarctic distribution are fairly well represented as fossils. Furthermore, the Neotropical species are dominantly tropical, and the Australian species are almost entirely in the northern, tropical part of the continent, where the fauna is more Indo-Australian. Thus the subfamily is a tropical group at present, with, however, a considerable development in the Palearctic region.

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† This section was not revised after the manuscript was originally submitted in 1945.

TABLE VI

Genera and species of Cassidinae by Zoogeographical Regions

Region	No. of genera	No. endemic genera	% genera endemic	No. of species	% species endemic
Neotropical	107	96	91	1,663	99
Nearctic	15	2	13	31*	61
Palearctic	12	8	67	102	93
Ethiopian	34	28	82	645	100
Africa	30	24	80	443	100
Madagascar	11	4	36	202	100
Oriental	27	15	55	445	98
Australasian	11	5	45	73	97
Indo-Australian**	8	2	25	44	93
Australia	6	3	50	28	100
Pacific Is.***	0	—	—	0	—
New World	109	109	100	1,682	100*
Old World	48	48	100	1,354	100

---

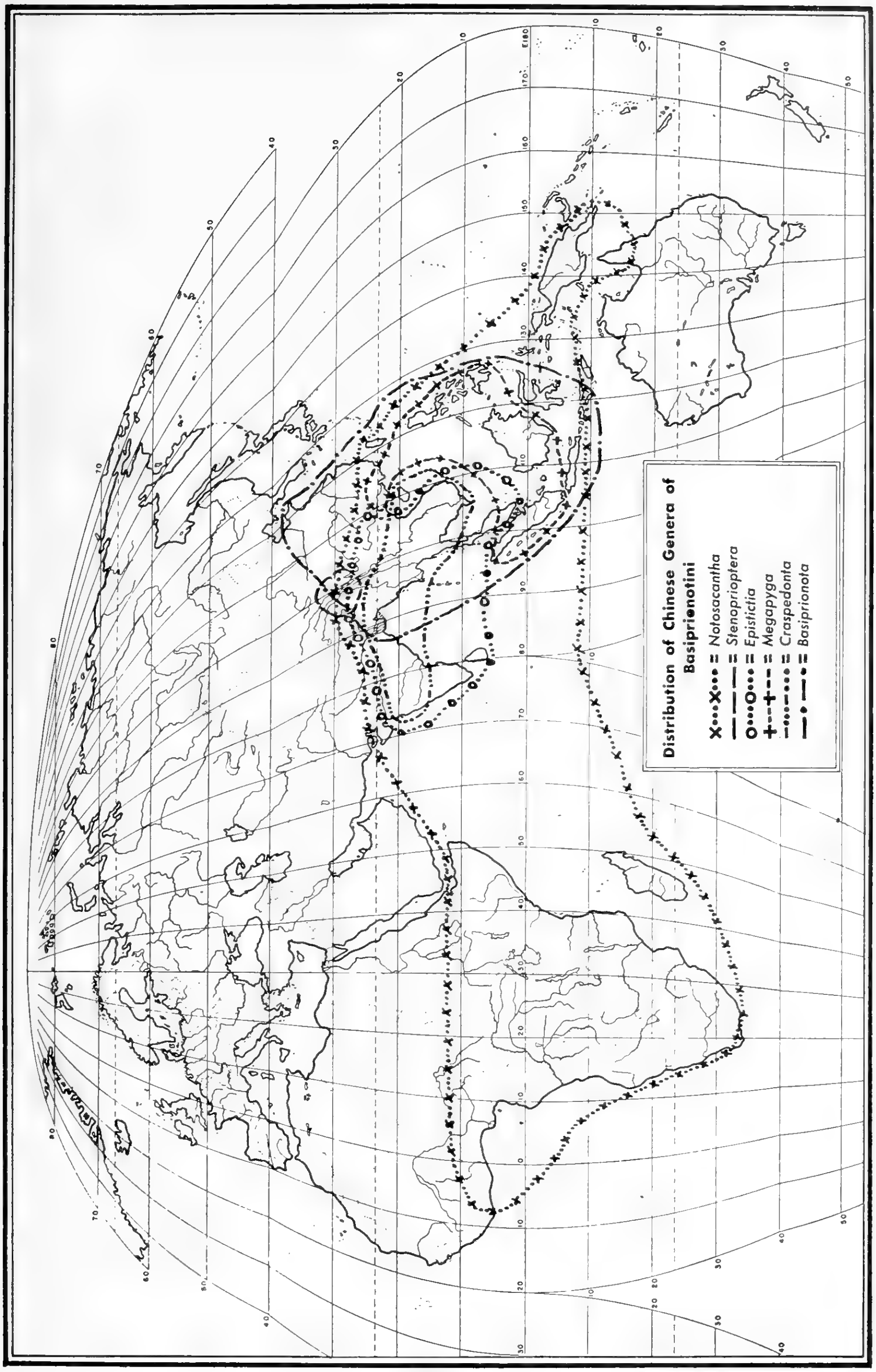
* European species introduced into North America are not taken into account.

** For the purposes of this study, the Indo-Australian Subregion is interpreted as including the Moluccas, the Lesser Sunda Islands, New Guinea, the Solomon Islands and New Caledonia, and excluding the Philippine Islands.

*** Under this category are included Tasmania, New Zealand, and the Pacific Islands north and east of the Solomons and New Caledonia.

To further evaluate the significance of this striking world distribution, a comparison has been made, in table VII, of the world distribution of each of the 16 subfamilies of Chrysomelidae. From this table it will be seen that the three most primitive subfamilies, Orsodacninae, Sagrinae, and Donaciinae, are the only ones which are not unquestionably dominantly tropical. Furthermore, Sagrinae is the only dominantly Australian group, and the other two are the only ones, aside from the small subfamily Lamprosominae, which by any means approach their ratio of 50 per cent or more of their genera Holarctic or cosmopolitan in distribution. Also all three of these groups are at present dominantly Old World in constituency. Thus the case of these three is diametrically opposed to the situation in the Cassidinae, where the group is dominantly tropical, dominantly New World, almost lacking in the Nearctic region, without any genera common to the Old and New Worlds, and thus apparently lacking in any evidence of holarctic distribution. The situation in the subfamilies other than those discussed above is more similar to the situation in the Cassidinae, although only the Hispinae, their closest relatives, have such a striking division between the Old and New World faunae except the Megascelinae, which are entirely Neotropical, and the Megalopodinae, which are like the previous named, relatively small.

It may also be seen that the characteristic of being dominantly New World, as far as numbers of genera is concerned, is less often the case than


Distribution of Chinese Genera of Basiprionotini
x•••x••• = Notosacantha
—— = Stenopriopterа
o•••o••• = Epistictia
+---+--- = Megapyga
-•••-••• = Craspedonta
—•—•— = Basiprionota

Map 1

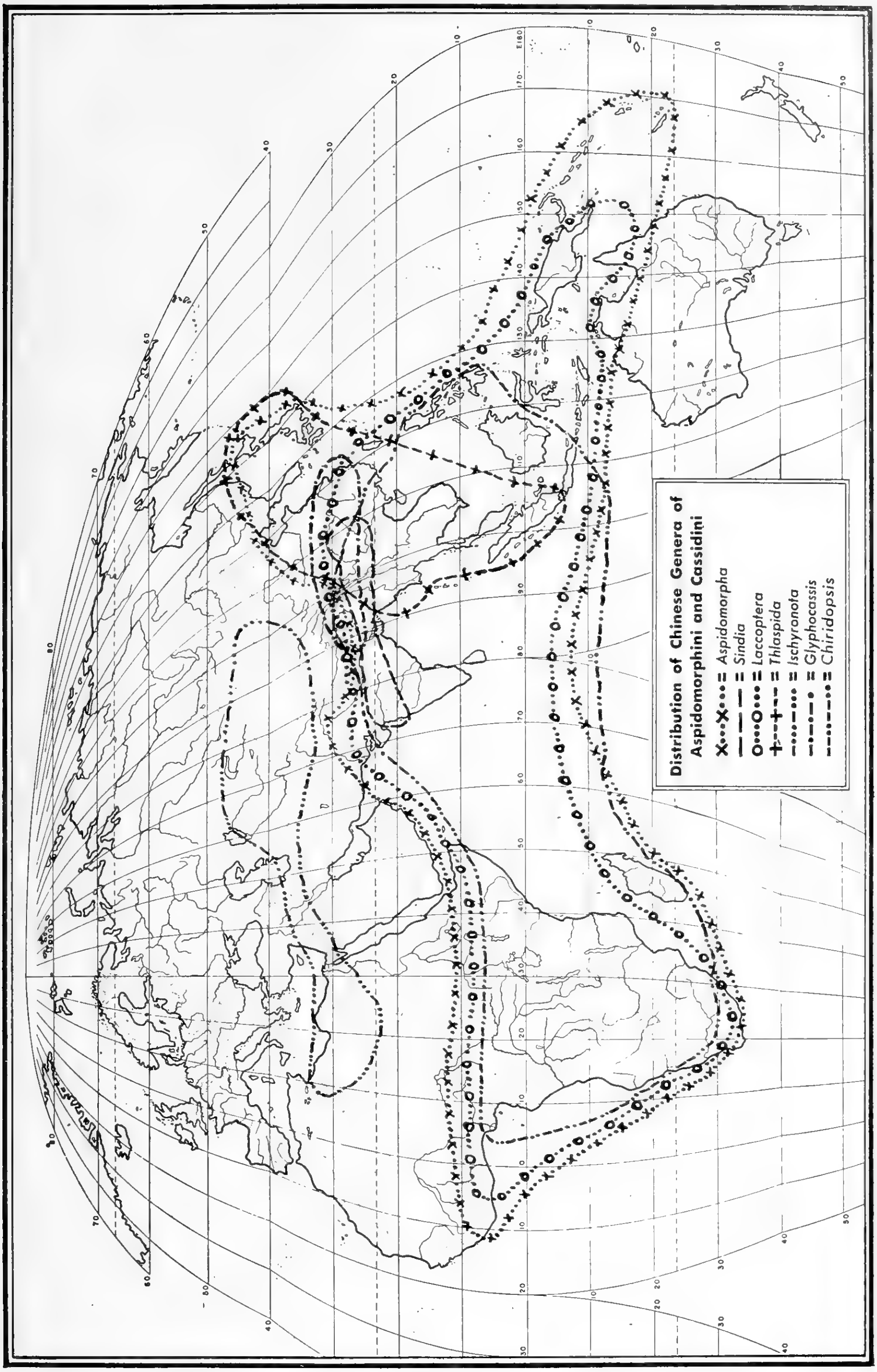
the opposite. An "X" in parentheses indicates that the situation is about half and half.

I consider the above facts as added evidence that the Cassidinae, together with the Hispinae, constitute an ancient group, and that the great differences between their New and Old World constituents are related to

Table VII

World distribution of the subfamilies of Chrysomelidae

				Genera				
Subfamily	Dominantly tropical	Dominantly Old World	Approx. No. Spp.	Approx. No. Gen.	No. Holarc. or Cosmop.	% N. Z and Australia	% Neotropical	Additional Notes
Orsodacninae	—	X	60	5	3	0	(20)	Mostly Holarctic and Asiatic. Few Neotropical species.
Sagrinae	(X)	X	105	16	0	75	12	None Nearctic or Palearctic.
Donaciinae	—	X	120	6	3	33	0	Non-Holarctic genera very small. Few tropical spp.
Criocerinae	X	X	1100	13	2	23	15	Cosmopolitan.
Megascelinae	X	—	125	2	0	0	100	Species entirely Neotropical.
Megalopodinae	X	X	330	14	0	0	36	None Nearctic or European.
Clytrinae	X	(X)	1100	35	2	3	48	Three of the four tribes are Neotropical.
Cryptocephalinae	X	X	2500	50	2	46	4	Cosmopolitan genera large.
Chlamisinae	X	—	400	7	1	0	57	Mostly in cosmopolitan genus *Chlamisus*.
Lamprosominae	X	—	180	4	2	0	100	Species largely Neotropical; few African or Palearctic.
Eumolpinae	X	X	3500	310	5	8	29	Of 26 tribes, 12 entirely Old World, 3 Neotropical.
Chrysomelinae	X	X	2700	130	6	28	18	Two tribes lacking in New World, 4 dominantly Australian.
Galerucinae	X	X	4000	325	7	3	1	Of 7 tribes, 6 dominantly Paleotropical, 1 dom. Palearctic, 1 lacking in New World.
Halticinae	X	X	5000	335	20	6	30	Cosmopolitan.
Hispinae	X	(X)	2000	100	0	5	47	Old and New World tribes entirely separate.
Cassidinae	X	—	3040	157	0	2	69	Of 4 tribes, largest only Neotropical, smallest only Paleotropical.


Distribution of Chinese Genera of Aspidomorphini and Cassidini
X••••X•••• = Aspidomorpha
——— = Sindia
O••••O•••• = Laccoptera
+–-–+–-– = Thlaspida
–••••–••• = Ischyronota
–•–•–• = Glyphocassis
–•–•–•–• = Chiridopsis

Map 2

their host plant preferences combined with their tropical nature and their probably relatively low survival ability under adverse conditions, as suggested in part by their specialization and their scarcity on, or absence from, small islands.

FAUNAL ANALYSIS OF THE CHINESE CASSIDINAE

It is well known that China is divided roughly in half between the Palearctic and Oriental regions in the zoogeographical sense. Thus with a tropical group the majority of species are to be found in the southern, or Oriental (zoogeographical sense), portion. The Cassidinae being both dominantly tropical and having a fairly considerable development in the Palearctic region, many species are to be expected in the country, and their occurrence is expected in all, or most, parts of the country. Such proves to be the case. In table VIII the numbers of genera and species of Cassidinae known from various portions of the country and neighboring islands are listed, together with indications of endemism in the areas concerned and figures showing the number of species each of these areas has in common with each other area, as well as certain regions outside the country.

From a study of table VIII it is evident that the entire Palearctic portion of China has far fewer endemic species, both actually and proportionately to the number indigenous. Thus many of the species in North China, as well as Japan, range across Siberia or Central Asia, even to Europe. Over half of the species so far known from North China, Japan, and Central Asia occur also in Europe. The general area of highest endemism, as far as China as a whole is concerned, is the area termed southeast China.

Certain genera, notably the genus *Notosacantha,* the most primitive, have species with apparently rather restricted distribution, while others, such as *Aspidomorpha* and *Cassida,* have many species of wide distribution. On maps 1–3 the known distribution of each of the genera and subgenera known from China is outlined. This illustrates which genera are principally Oriental and which are Palearctic.

The knowledge of Chinese Cassidinae, as well as of most or all other groups of Chinese insects, has not yet reached a very perfect or advanced stage. This is evident from the paucity of records for many species, gaps in distributional plotting and the very small number of subspecific assignments made for the known forms. However, I attempt below, on the basis of this study, correlated with work in other groups of Chinese beetles, as well as a limited familiarity with the distribution of terrestrial vertebrates and plants in China, to establish a basis for a life-zonal arrangement of the country. The following divisions are suggested, being very roughly outlined

TABLE VIII

Statistical analysis of geographical relationships of Chinese *Cassidinae*

	Genera		Species			Number of species in common with																	
						Oriental									Palearctic								
Area	Total	Endemic	Total	Endemic	% endemic	Philippines	Malacca, Sunda Is.	India	Indo-China Burma, Thai	Hainan I.	S. China	SE. China	Taiwan (Formosa)	W. China	C. Asia	N. China	Korea	Kyushu	Honshu	Hokkaido	Sachalin	Siberia	Europe
China, Korea & Japan	14	1	92	48	52	5*	10	12*	19	21	51	36	22	28	16	16	10	6	17	6	1	18	9
China	14	1	87	45	51	5	10	12*	19	21	51	36	22	28	16	16	10	6	11	5	1	14	7
Hainan Island	8	0	20	5	25	5*	9	8	14	—	13	13	5	4	0	1	0	3*	2*	0	0	1	0
South China	12	1	51	24	47	4*	8	10*	19	13	—	35	12*	24	3	7	2	6	10	3	1	5	2
SE. China	9	0	36	11	30	4*	7	7	15	13	35	—	11*	12	3	7	3	6	10	3	1	4	1
Taiwan (Formosa)	6	0	22	7	32	1*	2	4	10	5	12*	11*	—	5	4*	7*	4*	4	8*	2*	1*	5	1
West China	10	1	28	12	43	2*	4	7*	8	4	25	12	5	—	1	1	1	3	5*	1	1	3	2
C. Asia	2	0	16	2	13	0	0	0	0	0	3	3	4*	1	—	8	5	1	5	2	1	9	5
North China	5	0	16	0	—	0	0	0	2	1	7	8	7*	1	8	—	8	4	10	5	1	10	2
Korea	3	0	10	0	—	0	0	0	1	0	2	3	4*	1	5	8	—	3	8	5	1	9	1
Japan	3	0	19	1	5	1*	1	1	2	2	5	6	8*	4	5	11	8	—	—	—	1	14	4
Ryukyu Islands	2	0	4	0	—	1*	1	1	2	2	3	3	3	1	1	3	2	2	3	0	0	3	0

* One subspecific relationship is included in these figures.

on map 4, on the basis of the combined ranges of the species characteristic of the zones.

PALEARCTIC REGION

Some workers have attempted to divide China into the two zoogeographical regions, Palearctic and Oriental, by drawing a line across the country from east to west, roughly along the route followed by the great Yangtze River, from eastern Tibet, just north of the Himalayas, to the river's mouth. I believe, however, that such a line can only indicate the difference in average majority of Palearctic and Oriental species for the areas thus separated, since the river is not a barrier, at least to very many forms of life. The Palearctic region extends southwestward from eastern China along the mountain ranges of Southeast China parallel to the coast. It also occurs on Taiwan (Formosa) above altitudes of about 1,500 meters in the north and 2,000 meters in the south. It may be divided into the following three zones:

Upper Manchurian Zone: Low altitudes from Harbin northward, including the mountains of North China, Korea, and Japan and the mountains of Taiwan (Formosa) above 2,400 meters in altitude. Also including the lowlands of Hokkaido and Sachalin, and extending as far north in Siberia as most forms of life occur near sea level. The mountains in this northernmost area and the higher mountain tops of North China and Japan must fall in approximately the same category as the Arctic-Alpine fauna of the Nearctic region, since there is rather little in the way of inter-continental barrier for some forms of life in that zone.

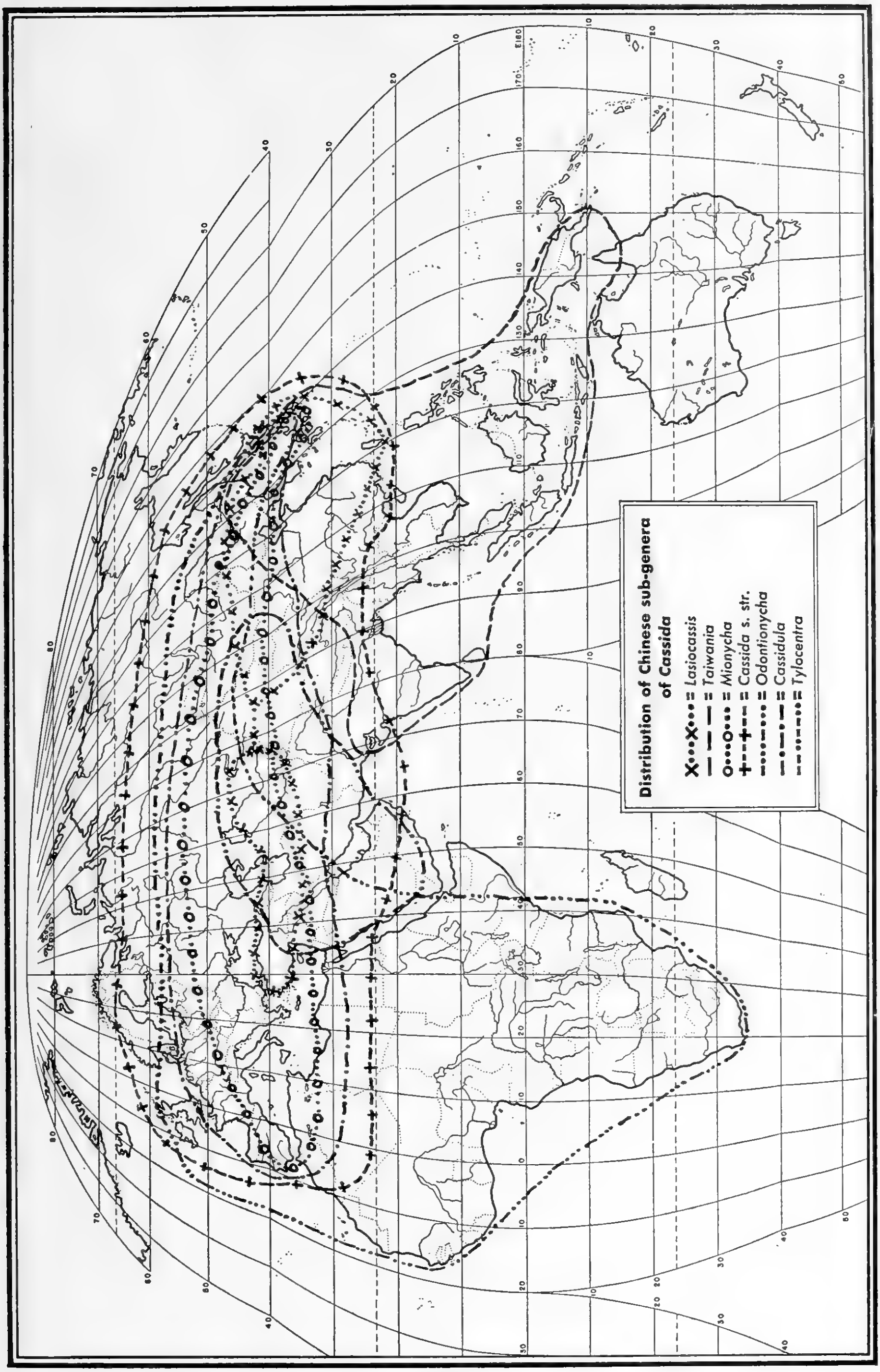
Lower Manchurian Zone: Low altitudes north to Harbin, including Japan; medium altitude areas bordering the Yangtze River and high altitudes in South China (1,000 to 2,000 meters in Southeast China and higher and farther north in West China).

Central Asian Zone: High altitudes in Tibet (exclusive of Sikang); medium to low altitudes, and most of plateau and desert areas, of Mongolia, Tsinghai, and Sinkiang.

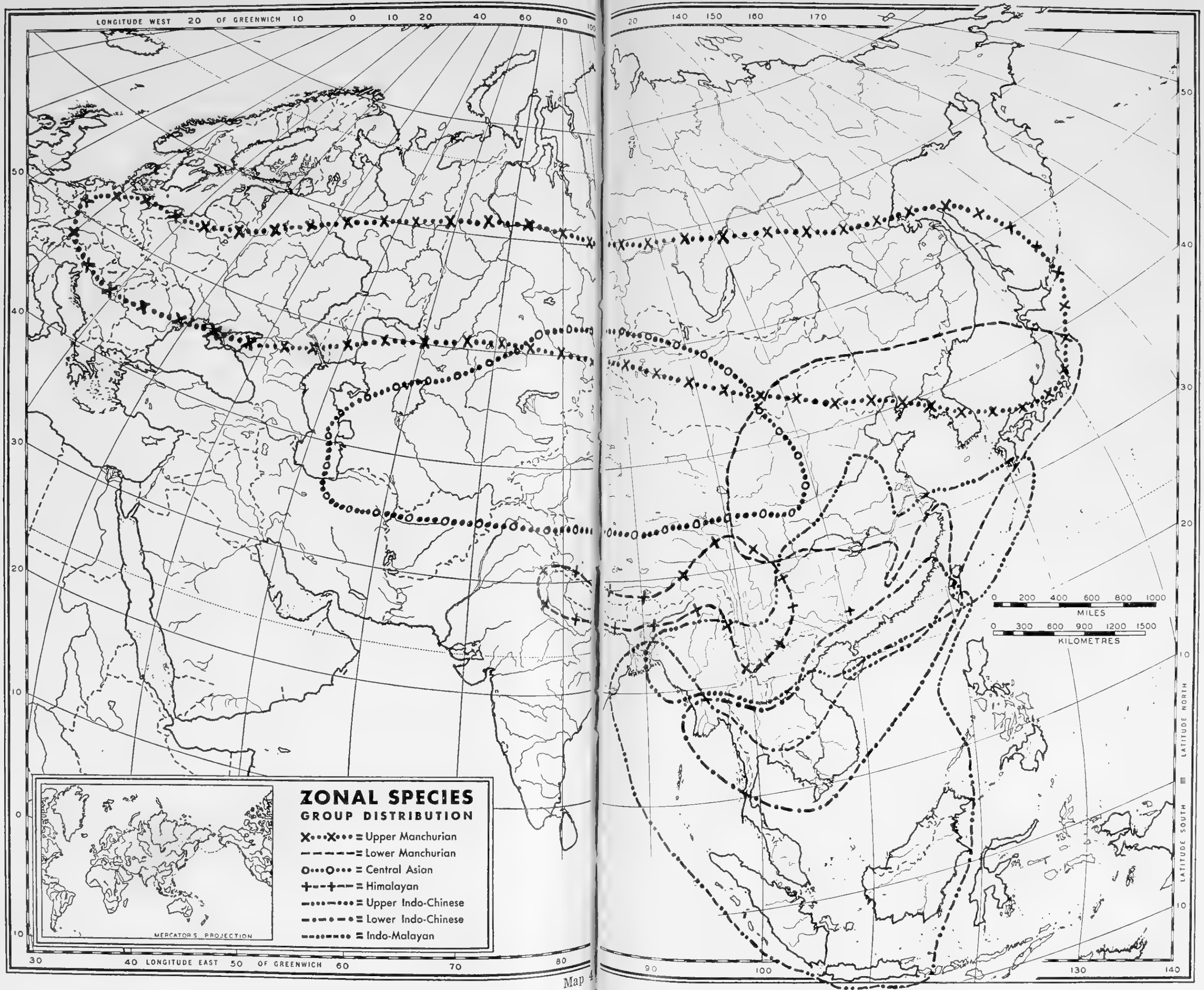
ORIENTAL REGION

The Oriental region extends northward in the valleys of Sikang and Szechuan, broadly overlaps the Palearctic in central and eastern China, and is dominant in the Ryukyu Islands, having had some considerable influence in Kyushu and to some extent Shikoku and southern Honshu. It is hardly evident in Korea. It may be divided into the following four zones:

Himalayan Zone: From the southern slopes of the Himalayas eastward into most of Assam, Sikang, and the mountains of Yunnan, Szechuan, and


Distribution of Chinese sub-genera of Cassida
= Lasiocassis
= Taiwania
= Mianycha
= Cassida s. str.
= Odontionycha
= Cassidula
= Tylocentra

Map 3


ZONAL SPECIES
GROUP DISTRIBUTION
X•••X••• = Upper Manchurian
– – – – – = Lower Manchurian
O•••O••• = Central Asian
+–+–+–– = Himalayan
–•••–••• = Upper Indo-Chinese
–•–•–• = Lower Indo-Chinese
–••••–•••• = Indo-Malayan
MERCATOR'S PROJECTION
LONGITUDE WEST 20 OF GREENWICH 10
LONGITUDE EAST 50 OF GREENWICH
MILES
KILOMETRES
0 200 400 600 800 1000
0 300 600 900 1200 1500
LATITUDE NORTH
LATITUDE SOUTH

Map 4

Kweichow. Also restricted occurrence at medium high altitudes in the mountains of Southeast China and Taiwan (Formosa).

Upper Indo-Chinese Zone: The low and medium-high mountains of Burma, Yunnan, Kweichow, southern (lower altitudes) Szechuan, most of the hill country of South China, including the lowlands in southcentral China and the highlands in Kwangtung, Fukien, southern Kwangsi, Indo-China, Thai, and southern Burma. Also the medium-low altitudes (600–1,800 meters) on Taiwan (Formosa), and most altitudes on the Ryukyu Islands. Only the highest mountains on Hainan Island.

Lower Indo-Chinese Zone: The low altitudes in Fukien, Kwangtung, Taiwan (Formosa), and Hainan and much of Indo-China and Thai.

Malayan Zone: Only a slight influence in lowland Hainan, southern lowland Taiwan (Formosa), and southernmost Kwangtung.

PHYLOGENY

The Cassidinae and the Hispinae together (Cryptostomata) apparently had a very early common origin. This may date back to the end of the Paleozoic era. The two subfamilies are still, however, not separated by a very wide gap, except as their biology and larval form is concerned. There are genera in South America, *Himatidium* in particular, which seem more like Cassidinae in their adult form, though their larvae demonstrate that they belong in the Hispinae. In the Oriental region there are genera, such as *Cassidispa* in the Hispinae and *Notosacantha* in the Cassidinae, both existing in China, which appear very similar to each other. Furthermore, species of the genus *Callispa* (Hispinae) also occurring in China, have somewhat expanded, and unspined, lateral margins of the pronotum and elytra, like so many of the primitive genera of the Cassidinae. The larvae of the former, however, are leaf-miners and have no caudal appendages.

The paleontological record is unfortunately not very extensive for the Cassidinae. All the known fossils are European. Most of them belong to the Pliocene period, and all of these probably belong to the genus *Cassida* or its immediate ancestors. There are two older fossils. One of these, called *Cassida aequivoca* Weyenbergh, 1869, from the Jurassic, is a poor specimen and very doubtfully a member of the genus *Cassida*. The other, *Oligocassida melaena* Theobald, 1937, from the Oligocene, is quite different from *Cassida*, and somewhat suggests the Neotropical genus *Deloyala* Chevrolat, though it may be more closely related to some existing African forms. It can hardly be ancestral to *Laccoptera, Aspidomorpha,* and *Thlaspida,* as the author asserts, since a common ancestor of members of the two tribes represented by these three genera would have to be much older than the Oligocene according to my opinion.

As to the phylogenetic relationship of the Chinese genera of Cassidinae, the genus *Notosacantha* is undoubtedly the most primitive. In fact it may well be one of the most primitive tortoise beetle genera of the world, for reasons suggested above. Though many primitive genera now exist in South America, it is not safe to assume, without further evidence, that the group originated in that region. It might have evolved in the Old World and lost more of the primitive types there through extinction. Many of these primitive genera belong to the large, endemic Neotropical tribe, called Tribe II (Spaeth, 1914–c), which may have had common ancestors with the Basiprionotini or branched off after it from the early common line which later gave rise to the ancestors of the Aspidomorphini and Cassidini. In the subtribe Basiprionotini proper, the genera *Megapyga* and *Basiprionota* are possibly to be united as subgenera of one genus.

In the tribe Cassidini there is some question as to whether *Ischyronota, Glyphocassis,* and *Chiridopsis,* the three Chinese genera with antennal grooves on the posternum, had a mutual common origin or whether they had separate derivations. In the genus *Cassida,* the subgenus *Lasiocassis* is thought to have separated from the ancestral stock earlier than the other subgenera, and there is some reason for considering it as a separate genus.

Summary and Conclusions

The subfamily Cassidinae is an ancient group, closely associated with the subfamily Hispinae. Together, these two groups are widely divergent from the remainder of the Chrysomelidae. Both are essentially tropical, are without any true Holarctic distribution, and have no genera in common between the Old and New Worlds. Furthermore, they are scarce in the Nearctic region, where their species are of recent Neotropical derivation. Cassidinae is well represented in Europe, though Hispinae has only two species there.

The Cassidinae have a distribution which is correlated with a restricted range of host plant preference. They are largely limited to certain higher families of sympetalous herbaceous dicotyledons which grow in open country or forest clearings. Thus both hosts and beetles are sun-loving, the latter being very active in the adult stage during sunny weather. The hosts of the European species are largely limited to plant genera of Old World origin. Plant genera in Europe, within the host families, which are considered to be of New World origin are rarely attacked. This, together with further evidence presented above, indicates that the host relationships have long been narrowly limited, and change very slowly. This is considered as partial evidence that the subfamily has a reduced genetic variability and is therefore archaic. Further evidence seems to lie in the fact that the group is lacking on oceanic islands and poorly represented on small continental islands where less plastic forms are more liable to extermination. Moreover, recent continental islands like the Japanese islands and Taiwan (Formosa) appear to have relatively fewer endemic species than is the case with many other groups of insects, the insular populations seeming in most cases to have failed to differentiate from the continental populations during millions of years of isolation. Still again, the most primitive Chinese genus of Cassidinae, *Notosacantha,* has species with much more restricted range than do the higher genera.

The Cassidinae may have originated either in the Old or New World. In either case the last interchange or migration of forms between the Old and New Worlds no doubt took place during the latest period that tropical conditions prevailed on the continental shelf uniting Asia and North America across the present Bering Sea region, in the Cretaceous or early Eocene at the latest. There is apparently no evidence for any Antarctic communication, with the absence of the Cassidinae from New Zealand, Tasmania, the Pacific Islands, and the temperate Australia. When, in the Tertiary, there was a temperate connection between Asia and North America, the tortoise beetles were evidently prevented from crossing over to North America from Asia. As the fossil record indicates, representatives of the genus *Cassida* must have already existed then in Europe. To explain the lack of dissemination at that time it is hypothecated that the land connection functioned as a filter-bridge closed to the Cassidinae by reasons of their particular host plant preference and sun-loving nature. The flora of the land bridge as far as known consisted of dense redwood forests and secondarily of hardwood forests, all of which may have meant a scarcity or lack of proper host types, conditions too shady for the beetles, or both.

Many of these remarks would appear likewise applicable in explaining the similar situation in regard to the Hispinae, which in the Old World are more particularly tropical than the Cassidinae and are also very restricted in their host relationships, being almost entirely confined to the Gramineae and Palmaceae.

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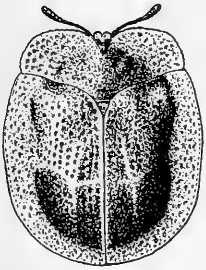
PLATE 27

Fig. 1. *Notosacantha marginalis* (Gressitt) X 6.7.
Fig. 2. *Notosacantha fumida* (Spaeth) X 6.7.
Fig. 3. *Aspidomorpha dorsata* (Fabricius) X 4.
Fig. 4. *Basiprionota whitei* (Boheman) X 4.
Fig. 5. *Sindiola hospita* (Boheman) X 4.
Fig. 6. *Basiprionota maculipennis reducta* (Gressitt) X 4.
Fig. 7. *Basiprionota chinensis* (Fabricius) X 4.
Fig. 8. *Craspedonta leayana insulana* (Gressitt) X 4.
Fig. 9. *Basiprionota bisignata* (Boheman) X 4.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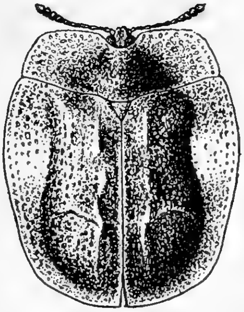
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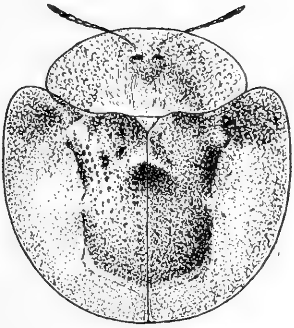
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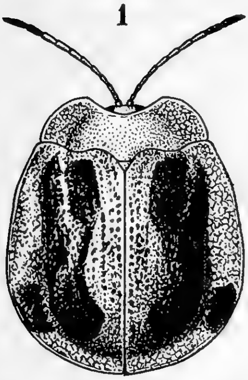
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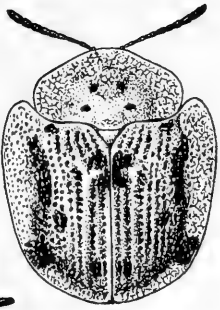
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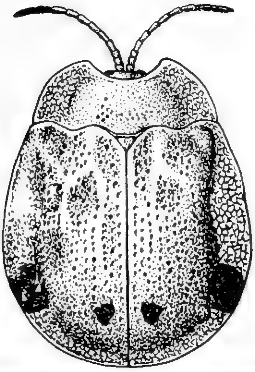
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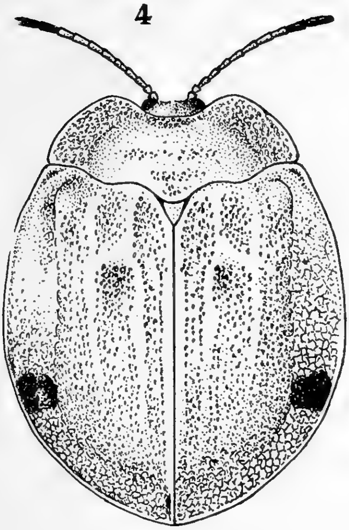
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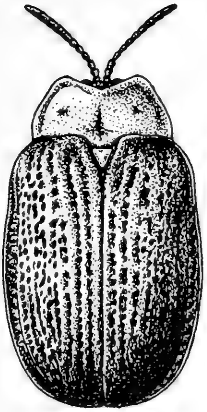
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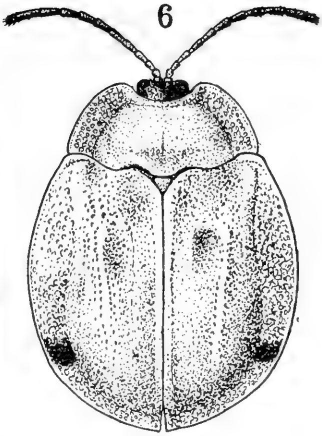
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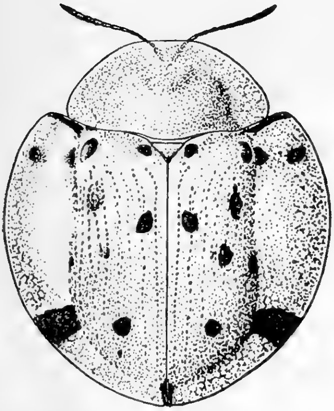
PLATE 28

Fig. 1. *Aspidomorpha miliaris* (Fabricius) X 4.
Fig. 2. *Cassida (Taiwania) circumdata* Herbst X 7.
Fig. 3. *Aspidomorpha sanctae-crucis* (Fabricius) X 4.
Fig. 4. *Cassida (Taiwania) plausibilis* (Boheman) X 7.
Fig. 5. *Cassida (Taiwania) spaethiana* Gressitt X 7.
Fig. 6. *Cassida (Taiwania) versicolor* (Boheman) X 7.
Fig. 7. *Glyphocassis trilineata szechuana* Gressitt, new subspecies, X 7.
Fig. 8. *Thlaspida lewisi* (Baly) X 7.
Fig. 9. *Thlaspida biramosa chinensis* Spaeth X 7.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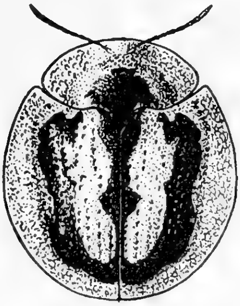
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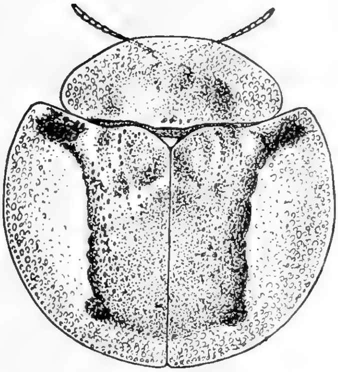
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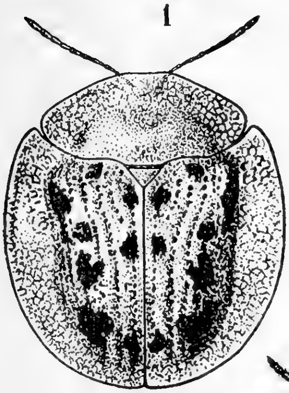
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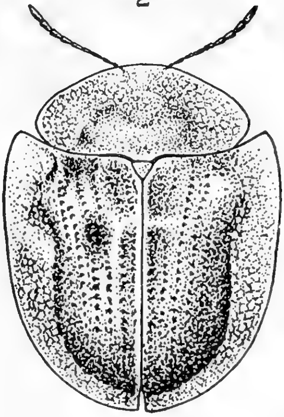
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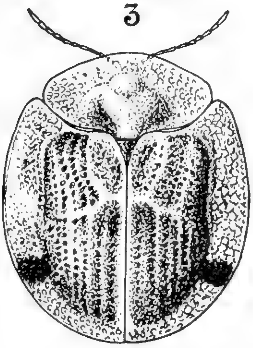
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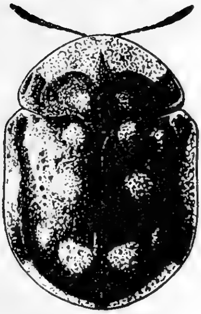
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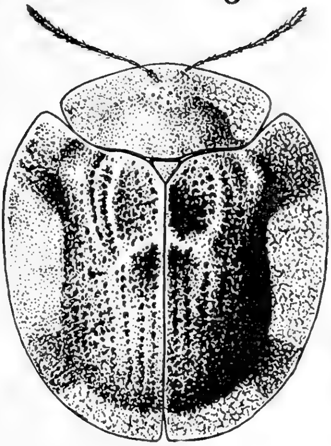
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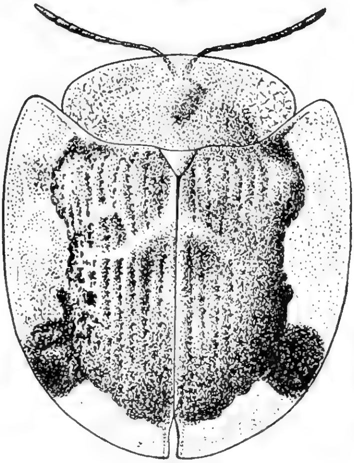
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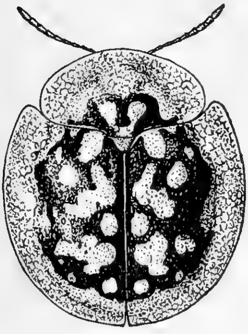
PLATE 29

Fig. 1. *Chiridopsis punctata* (Weber) X 6.
Fig. 2. *Chiridopsis bowringii* (Boheman) X 6.
Fig. 3. *Cassida* (s. str.) *klapperichi* Spaeth X 7.
Fig. 4. *Cassida* (s. str.) *pallidicollis* Boheman X 7.
Fig. 5. *Cassida* (s. str.) *jacobsoni* Spaeth X 7.
Fig. 6. *Cassida* (s. str.) *lineola* Creutzer X 7.
Fig. 7. *Cassida* (s. str.) *mandli* Spaeth X 7.
Fig. 8. *Glyphocassis lepida* (Spaeth) X 8.
Fig. 9. *Cassida (Taiwania) amurensis* (Kraatz) X 7.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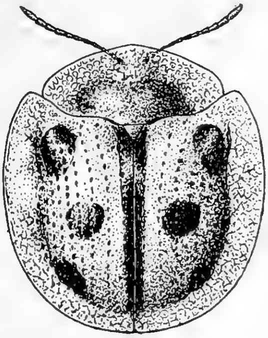
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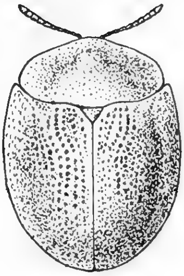
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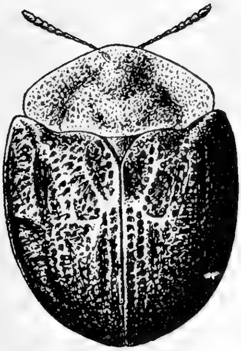
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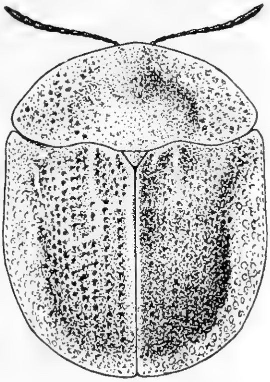
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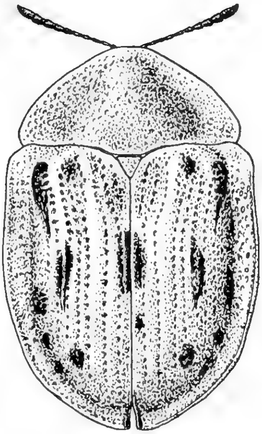
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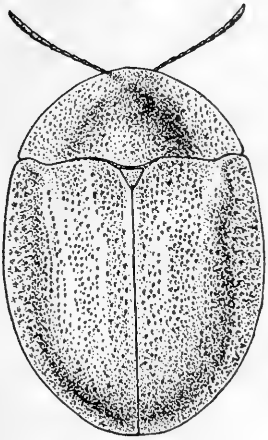
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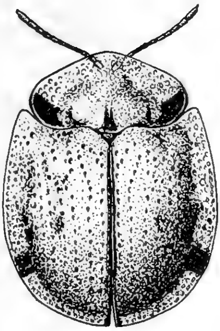
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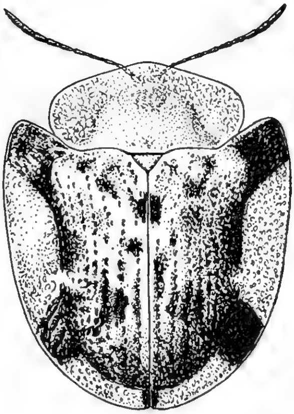
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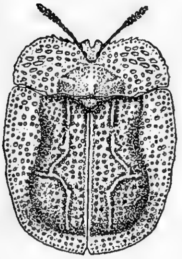
PLATE 30

Fig. 1. *Notosacantha oblongopunctata* (Gressitt) X 6.6.
Fig. 2. *Notosacantha sinica* Gressitt, new species X 6.6.
Fig. 3. *Notosacantha trituberculata* Gressitt, new species X 6.
Fig. 4. *Cassida (Taiwania) discalis* Gressitt X 6.
Fig. 5. *Cassida (Taiwania) imitatrix* Gressitt, new species X 7.
Fig. 6. *Cassida (Taiwania) insulana* Gressitt, new species X 6.
Fig. 7. *Cassida* (s. str.) *laticollis* Gressitt, new species X 5.5.
Fig. 8. *Cassida* (s. str.) *sikanga* Gressitt, new species X 5.4.
Fig. 9. *Cassida (Odontionycha) inflata* Gressitt, new species X 5.5.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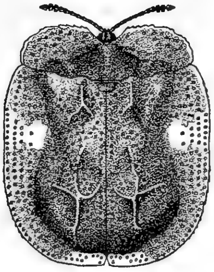
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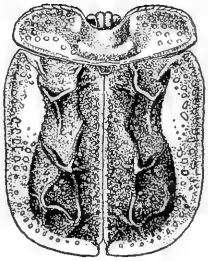
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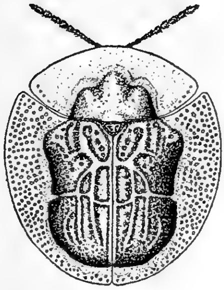
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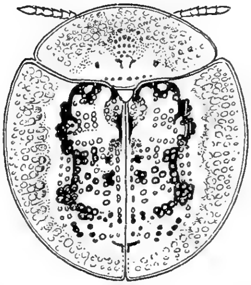
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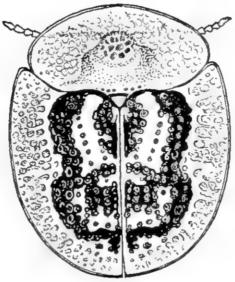
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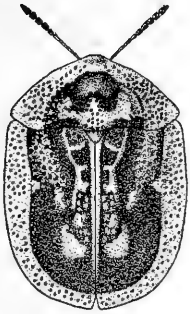
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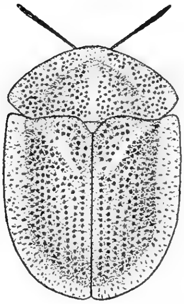
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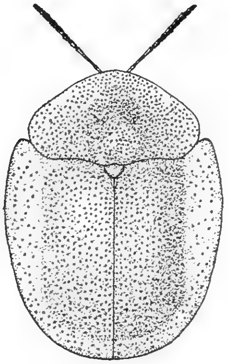
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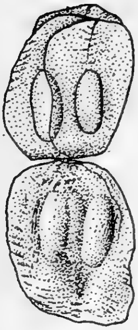
PLATE 31

Aspidomorpha furcata (Thunberg)

Fig. 1. Egg-case opened, showing two eggs above and three below, X 5.8.
Fig. 2. Egg-case, top view, X 5.8.
Fig. 3. First instar larva, caudal process directed backwards, X 5.8.
Fig. 4. Second instar larva, caudal process directed backwards, X 5.8.
Fig. 5. Third instar larva, caudal process in normal position, over body, X 5.8.
Fig. 6. Fourth instar larva, caudal process directed backwards, X 5.8.
Fig. 7. Fifth instar larva, prepupal stage, caudal process in normal position, over body, X 5.8.
Fig. 8. Adult of larval parasite, X 5.8.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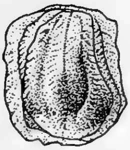
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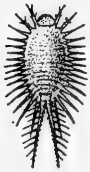
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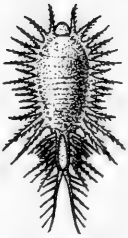
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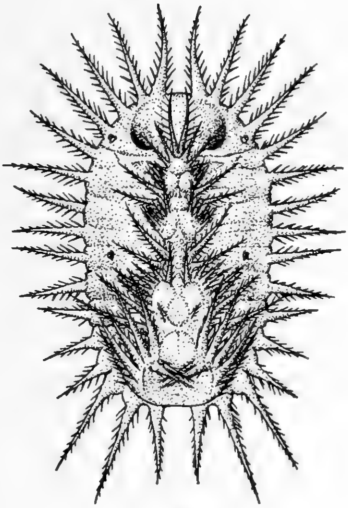
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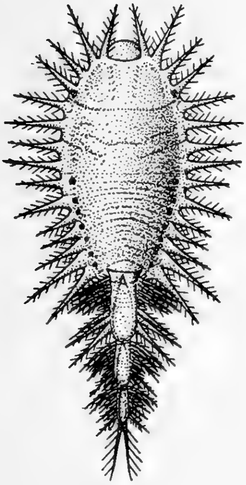
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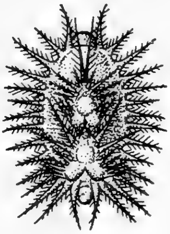
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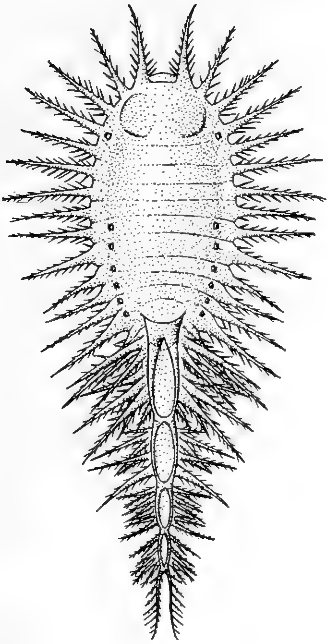
Plate 32

Aspidomorpha furcata (Thunberg)

Fig. 1. Fifth instar larva, dorsal view, caudal process directed backwards, X 6.7.
Fig. 2. Pupa, dorsal view, X 6.7.
Fig. 3. Pupa, ventral view, X 6.7.
Fig. 4. Adult, dorsal view, X 6.7.



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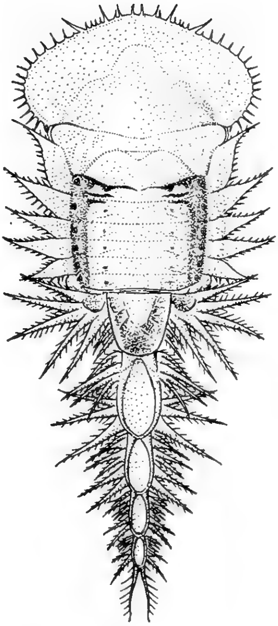

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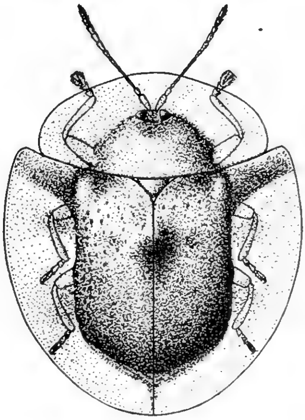

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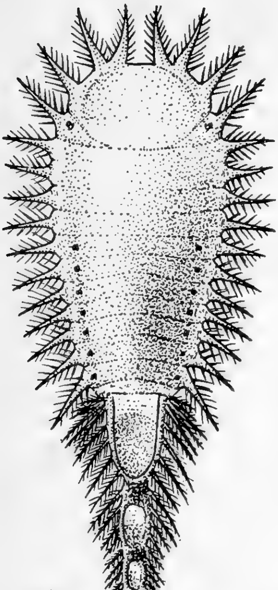
Plate 33

Cassida (s. str.) *japana* Baly

Fig. 1. Fifth instar larva, X 10.
Fig. 2. Fourth instar larva, X 10.
Fig. 3. Pupa, ventral view, X 10.
Fig. 4. First instar larva, X 10.
Fig. 5. Ootheca, dorsal view, X 10.
Fig. 6. Ootheca, ventral view, X 10.
Fig. 7. Third instar larva, X 10.
Fig. 8. Second instar larva, X 10.
Fig. 9. Pupa, dorsal view, with feces fork directed backwards, X 10.
Fig. 10. Adult, X 10.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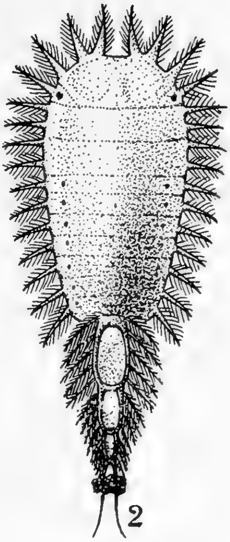
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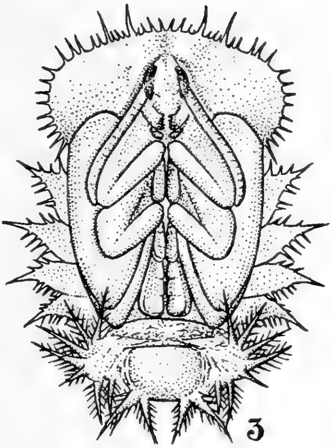
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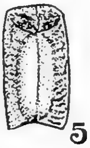
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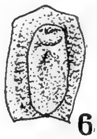
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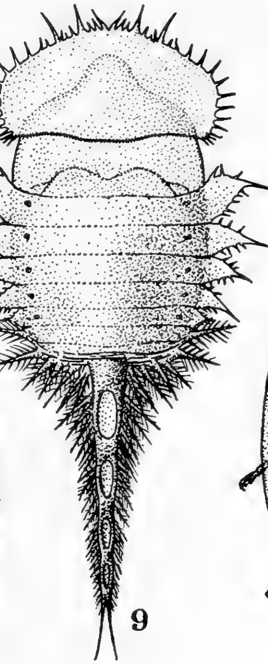
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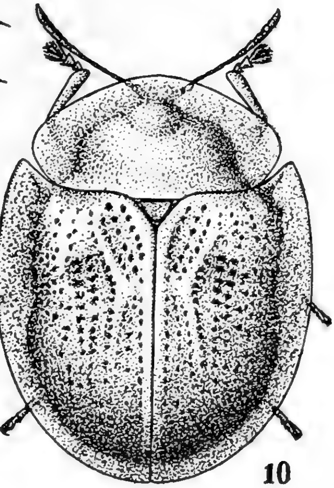
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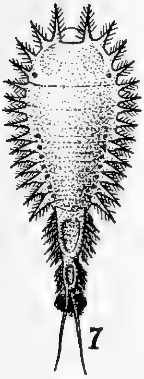
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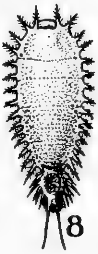
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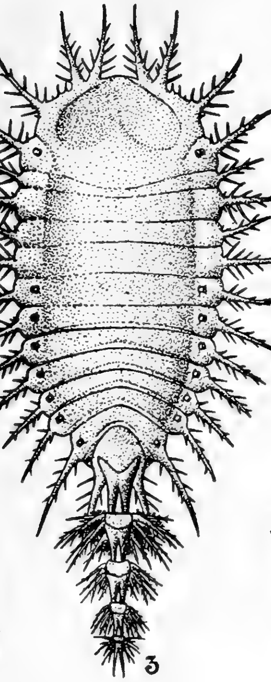
PLATE 34

Cassida (Taiwania) obtusata Boheman

Fig. 1. Ootheca, dorsal view, X 12.
Fig. 2. First instar larva, X 12.
Fig. 3. Fifth instar larva, X 12.
Fig. 4. Third instar larva, X 12.
Fig. 5. Pupa, dorsal view, with feces fork directed backwards, X 12.
Fig. 6. Second instar larva, X 12.
Fig. 7. Pupa, ventral view, X 12.
Fig. 8. Adult, X 12.
Fig. 9. Fourth instar larva, X 12.



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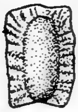

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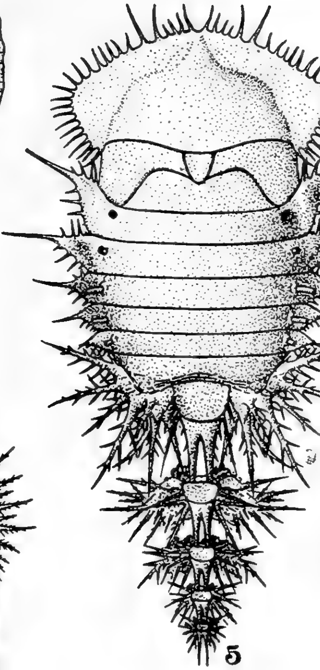

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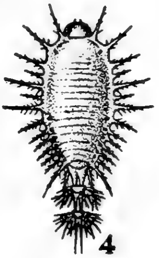

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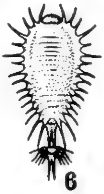

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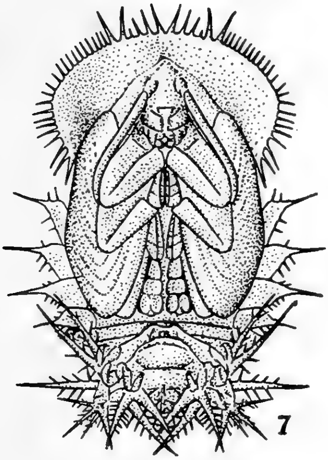

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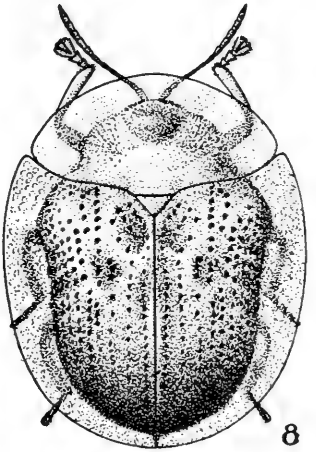

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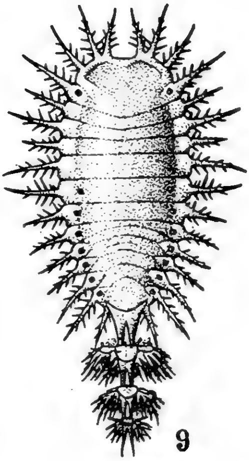

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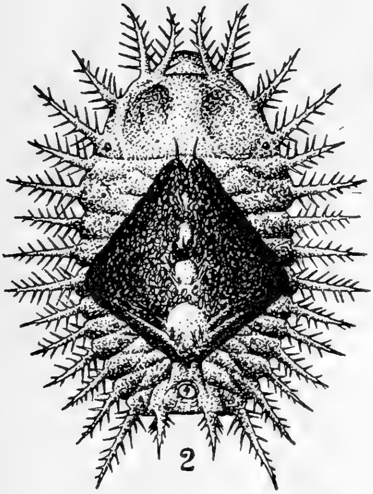
Plate 35

Laccoptera quadrimaculata (Thunberg)

Fig. 1. First instar larva, X 6.
Fig. 2. Fifth instar larva, X 6.
Fig. 3. Egg, removed from ootheca, X 6.
Fig. 4. Pupa, ventral view, X 6.
Fig. 5. Ootheca, with feces removed, dorsal view, X 6.
Fig. 6. Ootheca, with feces in place, dorsal view, X 6.
Fig. 7. Second instar larva, X 6.
Fig. 8. Fourth instar larva, X 6.
Fig. 9. Adult, X 6.
Fig. 10. Pupa, dorsal view, X 6.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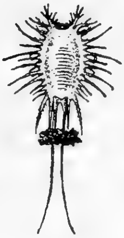
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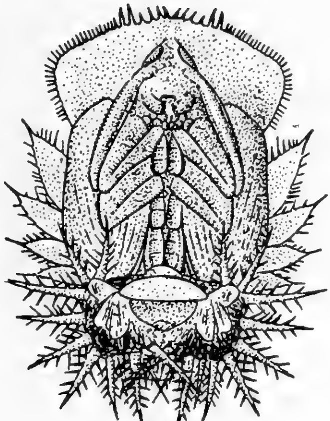
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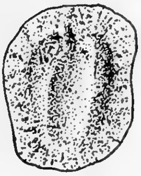
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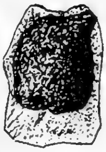
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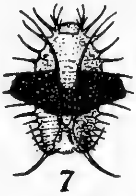
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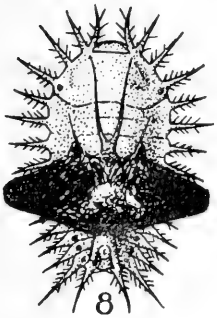
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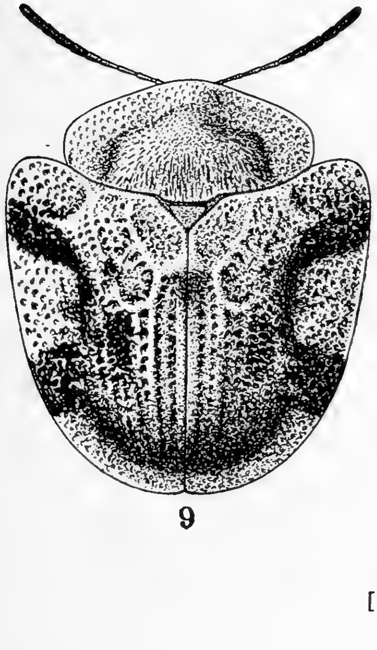
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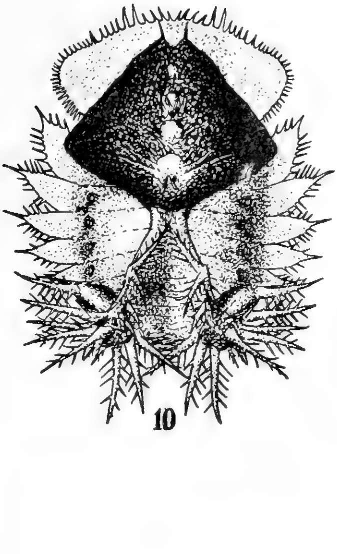
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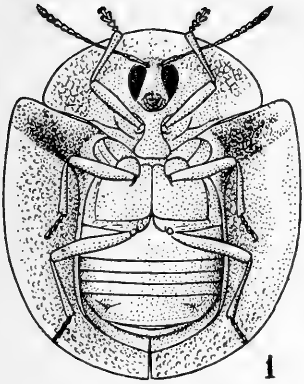
PLATE 36

Fig. 1. *Aspidomorpha furcata* (Thunberg), ventral view of adult, X 6.
Fig. 2. *Aspidomorpha miliaris* (Fabricius), dorsal view of pupa, X 4.
Fig. 3. *Aspidomorpha sanctae-crucis* (Fabricius), dorsal view of pupa, X 4.
Fig. 4. *Aspidomorpha furcata* (Thunberg), right wing, X 8.
Fig. 5. *Laccoptera quadrimaculata* (Thunberg), right wing, X 7.
Fig. 6. *Cassida (Taiwania) circumdata* Herbst, right wing, X 10.
Fig. 7. *Aspidomorpha furcata* (Thunberg), third instar larva with feces fork turned back, dorsal view, X 10.
Fig. 8. *Laccoptera quadrimaculata* (Thunberg), alimentary canal of adult, X 10,
Fig. 9. Adult of parasite of larva of *Cassida (Taiwania) circumdata* Herbst, X 14.



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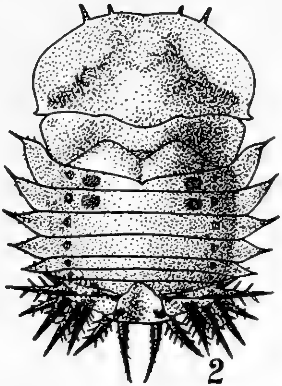

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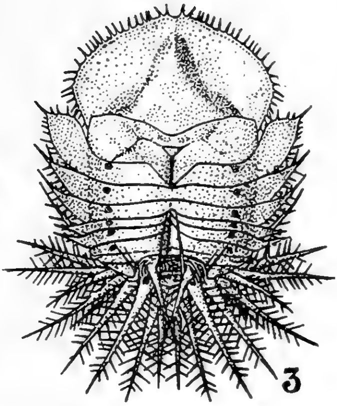

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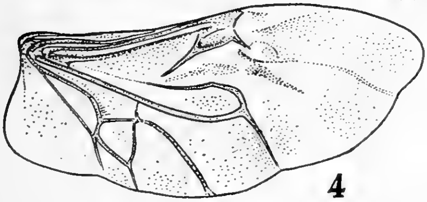

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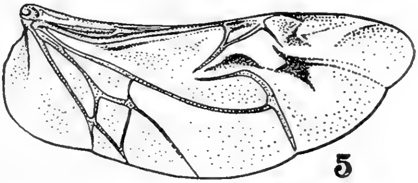

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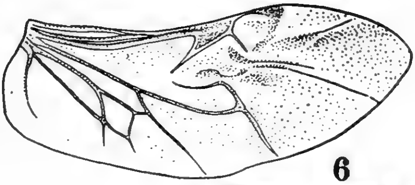

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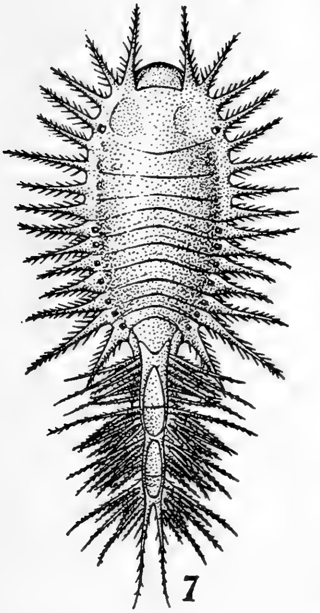

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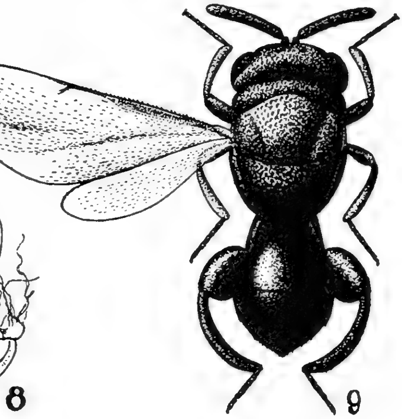

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INDEX

New names in **bold-face** type. Synonyms and names resulting from misidentifications, in *italics*.

PROCEEDINGS

OF THE

CALIFORNIA ACADEMY OF SCIENCES

Fourth Series

Vol. XXVII, No. 18, pp. 593–624, plates 37–41 March 30, 1953

SOME HEPATICAE FROM THE GALAPAGOS, COCOS, AND OTHER PACIFIC COAST ISLANDS

BY

LOIS CLARK

University of Washington

This is a report on a collection of Hepaticae sent us for determination by the California Academy of Sciences. They were collected chiefly by John Thomas Howell in 1931 and 1932, as a member of the Templeton Crocker Expedition, and by Alban Stewart in 1905 and 1906. Two packets were gathered by H. Walton Clark in 1932, also a member of the Crocker Expedition. Most of the material is from the Galapagos Islands, or from Cocos, Guadalupe, and Socorro islands. A few of the packets are from San Nicolas and Maria Madre islands, and from Nicaragua. The first set of specimens and the types are deposited in the Academy's herbarium, with duplicates in the University of Washington Herbarium.

The determinations were made in part by A. W. Evans, and in part by the writer who, however, studied all the material. The drawings were made in pencil by Dr. Evans, and inked by T. C. Frye who also prepared the manuscript for publication. Thus any errors may be attributed to the proper person.

Most of the packets contain mixtures. Each packet will probably be put into the herbarium under the name of the species first mentioned on the packet, which is usually the most abundant therein, or occasionally a rare species. To facilitate the finding of a packet containing a minor amount of material of a desired species, we state also the filing species of the packet if different. For example, if one wishes to examine *Cytolejeunea convexi-*

stipa he will find some of it in Howell's no. 227 filed under *Cheilolejeunea decidua.*

Since several of the islands on which collections were made are commonly not given on maps, because they are so far off shore from the continents, it is considered desirable that their location be indicated. For that reason the general regions of the collections are approximately given, except that the islands constituting the Galapagos group are not further located.

Localities

Cocos Island (Costa Rica). About 350 miles southwest of Costa Rica; Lat. 5° 35′ N., Long. 87° 2′ W.

Coseguina Volcano. Just south of the entrance to the Gulf of Fonseca, Nicaragua; Lat. 13° 23′ N., Long. 87° 37′ W.

Galapagos Islands (Ecuador). Lat. 0° 33′ S., Long. 90° 33′ W. The islands on which collections were made are Abingdon, Albemarle, Charles, Chatham, Duncan, Indefatigable, and James.

Guadalupe Island (Mexico). Lat. 29° 4′ N., Long. 118° 18′ W.; about one-third of the way down Lower California and about 200 miles west of its western shore. It should not be confused with Guadeloupe Island (France), on the eastern rim of the Caribbean Sea.

Gulf of Fonseca. At the northwest corner of Nicaragua.

Maria Madre Island (Mexico). Lat. 22° 13′ N., Long. 106° 10′ W.; the north island of the Tres Marias group.

Revillagigedo Islands (Mexico). A group of small, widely separated islands about 430 miles due west of Manzanillo, Mexico.

San Nicolas Island, California. Lat. 33° 15′ N., Long. 119° W.; about 100 miles southwest of Los Angeles.

Socorro Island (Mexico). Lat. 18° 45′ N., Long. 110° 54′ W.; one of the Revillagigedo group.

Tres Marias Islands (Mexico). About 65 miles off the coast of the State of Nayarit, Mexico.

Alphabetical List of Species

Those species herein reported from the Galapagos^{g}, Cocos^{c}, Revillagidedo^{r}, or Guadalupe* islands, and not previously known from that particular group or island, are indicated by letters as above.

***Asterella californica** (Hampe) Underw., Bot. Gaz., 20: 60, 1895. (*Fimbriaria californica* Hampe in Underw., Bull. Ill. State Lab. Nat. Hist., 2: 41, 1884.)

Guadalupe Island, above northeast anchorage, on slope, November 14, 1931 *(Howell 129, 134)*, and on Pine Ridge, on rocks and trees, November 15, 1931 *(135)*, also at 4000 feet, March 17, 1932 *(165)* and at 2000 feet *(167)*.

California, San Nicolas Island, March 13, 1932 *(Howell 149)*, and in packet of *Targionia hypophylla (150)*.

Asterella palmeri (Aust.) Underw., Bot. Gaz., 20: 63, 1895. (*Fimbriaria palmeri* Aust., Bull. Torr. Bot. Club, 6: 47, 1875.)

Guadalupe Island, north end, March 16, 1932 *(Howell 162)*, and south end of Cypress Forest, under rocks, March 17, 1932 *(169)*. Reported from Guadalupe (Sutliffe, 1932).

g**Bazzania teretiuscula** (Lindenb. & Gottsche) Trev., Mem. Istit. Lomb., 13: 414, 1877; *not* of Spruce Proc. Bot. Soc. Edinburgh, 15: 375, 1885. (*Mastigobryum teretiusculum* Lindenb. & Gottsche in G. L. & N., Syn. Hep., 720, 1847.)

Galapagos Islands, Indefatigable Island, Camp No. 2, altitude about 2000 feet, on sloping ground, in packet of *Bryopteris filicina*, May 9, 1932 *(Howell 212)*.

g**Brachiolejeunea densifolia** (Raddi) Evans, Bull. Torr. Bot. Club, 35: 158, 1908. (*Frullanioides densifolia* Raddi, Mem. Soc. Ital. Modena, 19: 38, 1823.) Galapagos Islands, Charles Island, April 25, 1932 *(Howell 196)*.

g**Brachiolejeunea grandidentata** Clark, new species.

Plants large, in depressed mats intermingled with other hepaticae, dull brownish green to brown; leafy shoots 2–3 mm. wide. Stems irregularly bipinnate, with subfloral innovations, about 170 μ in diameter; in cross section the cells about the same size throughout, walls thin. Leaves when dry wrapped about the stem. Dorsal lobe closely imbricate, spreading, ovate to oblong, about 1.9 mm. long as measured from insertion and 0.85 mm. wide; apex decurved, rounded-acute to apiculate; dorsal margin hardly or little crossing beyond the stem; base rounded to slightly cordate. Ventral lobe ovate-triangular in outline, about 710 μ long and 426 μ wide, its inflated water sac more than half the length of the lobule; keel straight, its base rounded, line of juncture of keel and lobe straight or curved; free margin rounded to base; margin with 4–6 large teeth; teeth 2–3 cells long, 2 or more cells wide at base, incurved toward dorsal lobe; apical tooth 4–5 cells long from a 2-celled base; hyaline papilla displaced to inner surface of ventral lobe, 2–3 cells from margin. Marginal cells of dorsal lobe subquadrate, 8–17 μ; median 25–34 μ long, 15–17 wide; basal 15–26 μ long, 8–11 μ wide; trigones present, somewhat bulging near middle of lobe and below; intermediate thickenings present, oval-oblong. Underleaves large, transversely inserted, subrotund, 710–730 μ long from insertion, 781–802 μ wide; apex rounded or truncate to retuse; margins entire; base auriculate; auricles entire. Plants bisexual. Male inflorescence below the female or on innovations; male bracts 6–10, imbricate, slightly smaller than the leaves; ventral lobe large, almost equaling the dorsal; stylar tooth clearly evident. Female inflorescence terminal on stem, forming innovations on both sides. Female bracts larger than the leaves, erect-spreading, 2-lobed; dorsal lobe united with the ventral for two-thirds its length, ovate to oblong, 1.5–1.7 mm. long, 700–850 μ wide, apex rounded and apiculate to obtusely pointed, sinuate; ventral lobe nearly as long as the dorsal, narrower, ovate, 0.81–1.06 mm. long, 319–390 μ wide, apex acute, margins entire; keel winged; the wing long-triangular, attached along its upper part, about 214 μ wide, its margin entire to sinuate or with 2–3 small teeth. Female bracteole oblong to obovate, 0.9–1.4 mm. long, 700–800 μ wide, apex rounded to truncate or retuse; margins entire. Perianth slightly exserted, becoming more so with growth of sporophyte, ovate-oblong, 1.5–1.7 mm. long, about 850 μ wide, pluricarinate; keels 10, extending half the length, rounded, separated by deep grooves; apex more or less truncate; beak short; mouth flaring. Spores yellow-brown; elaters 7 μ in diameter and bispiral at middle.

Plantae maiores fusco-brunneae aut brunneae. Caules 2-pinnati. Folia imbricata, arte circum caulem involuta cum arida, inaequaliter bilobata. Lobus dorsalis folii ovatus aut oblongatus, 1.9 mm. longus, 850 μ latus, apice decurvato, rotundato apiculatoque; margine integerrimo, basi circinata. Lobus ventralis ovato-triangularis, 710 μ longus, 426 μ latus; sacco aquario 355 μ longo; carina directa; margine soluto cum 6 dentibus maximis; dentibus 2–3 cellulas longis, a basi 2–4 cellulas latis, incurvatis ad lobum dorsalem; dente apicali 4–5 cellulas longo. Amphigastria maxima 710–730 μ longa, 781–802 μ lata; apicibus modo integerrimis modo retusis. Plantae monoeciae. Folia floralia magna, bilobata. Lobus dorsalis ovatus aut oblongatus; apice rotundato; margine integerrimo. Lobus ventralis ovatus, apice rotundato; marginibus sinuatis, integerrimis, alatis; alis longo-triangularibus; marginibus modo truncatis modo sinuatis modo cum 2–3 dentibus parvis. Amphigastria floralia oblongata aut obovata; apice truncato aut retuso; margine integerrimo. Perianthium pluricarinatum, apice truncato; rostro brevi; ore tubae simili.

Galapagos Islands, Charles Island, common on trees, October 7, 1905 *(Alban Stewart 769)*; Albemarle Island, above Santo Tomas, Villamil Mountain, on trees, April 29, 1932 *(John Thomas Howell 211A)*. Since most of the descriptions and drawings were made from *Howell's no. 211A* we suggest that be considered the type (Herb. Calif. Acad. Sci. no. 372,424).

Brachiolejeunea grandidentata is similar to *B. densifolia* (Raddi) Evans in general habit, in the auriculate underleaves, and in the pluriplicate perianth. The latter is a species ranging from Mexico and the Island of St. Vincent southward into Brazil and Bolivia, and occurs also in the Galapagos Islands. However *B. grandidentata* differs from *B. densifolia* in that the former is bisexual, has the dorsal leaf lobes more rounded, and has more and larger teeth on the ventral leaf lobes. In Howell's no. 211A *B. grandidentata* is intermingled with *Frullania atrata, F. arecae, Omphalanthus filiformis,* and *Rectolejeunea maxonii.*

Bryopteris filicina (Swartz) Nees in G. L. & N., Syn. Hep., 284, 1845. *(Jungermannia filicina* Swartz, Prodr. Fl. Ind. Occid., 145, 1788.)

Galapagos Islands, Albemarle Island, below Santo Tomas, on branches of trees in humid region, April 29, 1932 *(Howell 206);* Indefatigable Island, Camp No. 2, altitude 2000 feet, common on ground, May 9, 1932 *(Howell 212).* Known from the Galapagos Islands (Robinson, 1902, p. 100).

Bryopteris galapagona Gottsche., Ann. Sci. Nat., ser. 4, 8: 341, 1857. *(Jungermannia filicina* var. *tenuis* of Hook. in Trans. Linn. Soc., 20: 163–233, 1847.)

Galapagos Islands, Charles Island, common on bushes, in packet of *Frullania aculeata,* October 7, 1905 *(Stewart 765).* Known from the Galapagos Islands (Robinson, 1902, p. 100).

Bryopteris tenuicaulis Tayl. in G. L. & N., Syn. Hep., 285, 1845.

Galapagos Islands, Charles Island, common on rocks, October 9, 1905 *(Stewart 876),* also on trunks and branches of trees, May 15, 1906 *(7041):* Abingdon Island, common on trees, September 19, 1906 *(Stewart 8501):* Indefatigable Island, common on trunks of trees, July 23, 1906 *(Stewart 5102).* Known from the Galapagos Islands (Robinson, 1902, p. 100).

^{g}**Calypogeia miquelii** Mont. in G. L. & N., Syn. Hep., 200, 1845.

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, May 10, 1932 *(Howell 254, 258).*

^{g}**Caudalejeunea lehmanniana** (Gottsche) Evans, Bull. Torr. Bot. Club, 34: 554, 1908. *(Lejeunea lehmanniana* Gottsche in G. L. & N., Syn. Hep., 325, 1845.)

Galapagos Islands, Albemarle Island, south end, above Santo Tomas, Villamil Mountain, on branches of trees, in packet of *Frullania atrata,* April 29, 1932 *(Howell 215).*

^{c}**Ceratolejeunea lobata** Clark, new species.

Plants small, light yellowish brown; leafy shoots up to 1 mm. wide. Stems to 1.5 cm. long, pinnately branched; branches spreading at right angles to stem, up to 1 cm. long. Leaves contiguous to imbricate, spreading.

Dorsal lobe of leaf oblong-ovate, becoming falcate, 426–568 μ long and about 400 μ wide; apex rounded to obtuse or subacute; margin sinuate to entire or rarely with 2–3 more or less coarse teeth at apical region. Ventral lobe large, ovoid, about 14 × 8 μ, strongly inflated, or small and even reduced to a few cells, both types appearing on the same branch; apical tooth of small ventral lobe mostly straight, oval; that on larger ventral lobe long, bluntly pointed, curved; rarely 1–2 utricles present at bases of main branches. Cells of dorsal leaf lobes isodiametric, near apex 11–17 μ, median and basal 20–34 μ; walls uniformly rather thin; trigones wanting or very small; paracysts (ocelli) basal, in groups of 2–3. Underleaves distant, wider than the stem, about 100 μ long from insertion and 120 μ wide, 2-lobed to one-half their length, the lobes acute; insertion a transverse line. Plants bisexual. Male inflorescence not found. Female bracts slightly larger than the leaves, spreading, unequally 2-lobed. Dorsal lobe ovate, 686–775 μ long, about 450 μ wide; apex variable, obtuse to acute or apiculate; margin sinuate. Ventral lobe shorter than the dorsal but similar. Bracteole free, ovate, 2-lobed to one-third its length; lobes triangular, acute. Otherwise unknown.

Plantae minutae flavo-brunneae, 15 mm. longae. Caules pinnati; ramis 10 mm. longis. Folia propinqua aut imbricata; lobo dorsali oblongo-ovato, 426–568 μ longo, 400 μ lato; apice rotundato aut subacuto; marginibus integerrimis sinuosis aut cum 2–3 dentibus crassis; lobo ventrali magno, ovato, 14 μ longo, 8 μ lato, modo valide inflato modo ad paucas cellulas reducto; dente apicali magni lobi ventralis, obtuso, flexo; dente apicali reducti lobi ventralis erecto; utriculis 1–2, raris; paracystibus a basi 2–3. Amphigastria parva remota, 109 μ longa, 120 μ lata, ½ bifida. Plantae dioeciae. Folia floralia bilobata; lobo dorsali ovato, 686–775 μ longo, 450 μ lato; lobo ventrali simili lobo dorsali. Amphigastrium florale solutum, ovatum, ⅓ bilobatum.

Cocos Island, Wafer Bay, in packet of *Lopholejeunea cocosensis,* containing also *Plagiochila bursata, Radula affinis* and *Lejeunea setiloba,* June 28, 1932 *(H. Walton Clark 221, type,* Herb. Calif. Acad. Sci. no. 372,425).

Without the perianth *Ceratolejeunea lobata* is hard to place definitely. The following may help to distinguish it from *C. maritima* (Spruce) Steph., which is close to it: *(a)* The group of 1–3 paracysts (oscelli) at the base of the dorsal lobe of the former; *(b)* The teeth on the apical margin of the dorsal lobe; *(c)* The ventral lobe, either large and strongly inflated or reduced to a few cells; *(d)* The presence of a pair of utricles at the bases of some of the primary branches; *(e)* The small female bracts with entire to sinuate margins. *C. maritima* is highly variable, and *C. lobata* may well prove to be one of its variants.

^{gc}**Ceratolejeunea maritima** (Spruce) Steph., Sp. Hep., 5: 423, 1913. *(Lejeunea maritima* Spruce, Trans. Bot. Soc. Edinburgh, 15: 210, 1884.)

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, May 10, 1932 *(Howell 251, 252, 260),* also in packet of *Taxilejeunea pterogonia (253A, 253B),* of *Calypogeia miquelii (254),* of *Omphalanthus filiformis (255),* of *Leucolejeunea xanthocarpa (257),* of *Euosmolejeunea trifaria (263),* and of *Plagiochila bursata (264).*

Cocos Island, Wafer Bay, in packet of *Cheilolejeunea decidua,* June 28, 1932 *(Howell 227).*

^{g}**Ceratolejeunea spinosa** (Gottsche) Steph., Hedwigia, 34: 238, 1895. *(Lejeunea spinosa* Gottsche in G. L. & N., Syn. Hep., 402, 1845.)

Galapagos Islands, Indefatigable Island, near Camp No. 1, in packet of *Plagiochila bursata,* May 10, 1932 *(Howell 248).*

^{gc}**Cheilolejeunea decidua** (Spruce) Evans, Bull. Torr. Bot. Club, 32: 188, 1905. *(Lejeunea decidua* Spruce, Trans. Bot. Soc. Edinburgh, 15: 257, 1884.)

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, May 10, 1932 *(Howell 256),* and in packet of *Calypogeia miquelii (254, 258);* also near Fortuna, in packet of *Frullania riojaneirensis,* May 12, 1932 *(265B).*

Cocos Island, Wafer Bay, June 28, 1932 *(Howell 227),* also in packet of *Frullania cocosensis (226),* and of *Symbiezidium transversale (H. Walton Clark 230),* and at Chatham Bay *(Howell 235).*

Cololejeunea coseguinana Clark, new species.

Plants yellow-green to nearly colorless; leafy shoots up to 1.1 mm. wide. Stems prostrate, about 50 μ in diameter, very slightly geniculate, irregularly branched; in cross section with 5 peripheral cells; rhizoids moderately numerous. Leaves distant to subimbricate, obliquely to widely spreading, unequally 2-lobed, the dorsal lobe much the larger. Dorsal lobe convex, subrotund to broadly ovate, 320–380 μ long, 280–320 μ wide; apex rounded; margins crenulate with projecting cells; ventral margin forming a continuous line with the keel; dorsal margin hardly or not reaching the farther edge of the stem, at base not rounded but straight. Ventral lobe more or less quadrate, 170–204 μ long, 136–204 μ wide, with arched keel, a portion near keel inflated; free margin curved, somewhat involute for ⅓–½ its length, with apical tooth, and with a 2-celled tooth about half way on the straight or concave margin between the apical tooth and the distal end of keel; apical tooth obtuse to rounded; hyaline papilla at base of 1-2-celled tooth. Stylus reduced to a hyaline papilla *(fig. 3 h).* Cells of the dorsal leaf lobe bulging on the dorsal surface of the leaf, the apical ones about 17 μ, the median 23 μ and the basal 18–23 μ; trigones wanting; walls thin. Underleaves wanting. Gemmae usually on the ventral surface of the male bracts, flat, discoid, 50–60 μ in diameter, of about 24 cells. Plants bisexual. Male inflorescence on more or less elongate branches, spike-like; bracts 6–10, subequally 2-lobed; dorsal lobe rather larger, very concave, rounded; ventral lobe entire. Female inflorescence terminal on a main shoot; subfloral innovations present. Female bracts very unequally 2-lobed. Dorsal lobe ovate, about 355 μ long and 213 μ wide; apex obtuse to rounded; margins crenulate. Ventral lobe reduced, oblong, about 255 μ long and 64 μ wide; apex obtuse; margin crenulate by projecting cells. Perianth obovoid to pyriform, rounded or less rapidly contracted toward apex, sharply 5-keeled in upper part; surface rough with bulging cells; beak very short. Sporangia spherical. Seta short, in cross section 4 cells thick.

Plantae flavo-virides aut hyalinae. Caules procumbentes, ramis incomposite diffusis, 50 μ per medium. Folia remota aut subimbricata, bilobata inaequaliter; lobo dorsali convexo, subrotundato 320–380 μ longo, 280–320 μ lato; apice rotundato; marginibus crenulatis ob cellas prominentes; lobo ventrali subquadrato, 170–204 μ longo, 136–204 μ lato; carina arcuata; dente apicali obtuso aut rotundato; margine flexo, involuto, dente 1–2-cellas longo, in medio inter basim carinae et dentem apicalem locato; papillis hyalinis a basi dentis 2-cellas lati; stylo papilla hyalina reducto. Plantae monoeciae. Folia floralia bilobata inaequaliter; lobo dorsali ovato; apice obtuso aut rotundato; marginibus crenulatis. Perianthium obovatum aut pyriforme, parte superiore cum 5 carinis; superficie aspera; rostro brevi. Sporangium sphaericum; setis brevibus, 4-cellas latis per medium. Gemmae in superficie ventrali foliorum masculinorum locatae, orbes 24 cellarum, 50–60 μ latae per medium.

Nicaragua, Gulf of Fonseca, east of Volcano Coseguina, July 7, 1932 *(John Thomas Howell 245, type,* Herb. Calif. Acad. Sci. no. 372,426), and in packet of *Lejeunea setiloba (242, 270).*

Cololejeunea coseguinana is closely related to *C. myriocarpa* (Nees & Mont.) Steph. *(pl. 41, fig. 4)* but the former differs in having: *(a)* Round or obovate dorsal leaf-lobes; *(b)* A distinct ventral leaf-lobe with definite apical tooth; *(c)* The hyaline papilla not marginal but at the base of the apical tooth; *(d)* The ventral lobe of the female bract reduced but still evident; *(e)* The gemmae composed of 24 cells; and *(f)* The margins of the gemmae not crenulate. Evans (1911, p. 281) says: "In the various species where gemmae are found they may differ in size and number of cells, but for a given species, the number of cells is fairly constant."

Cololejeunea coseguinana is also close to *C. minutissima* (Smith) Schiffn. *(pl. 41, figs. 1–3)* but differs in that *(a)* The former is a larger plant; *(b)* With the basal margin of the dorsal leaf-lobe not rounded but straight; *(c)* The hyaline papilla is at the base of the apical tooth; *(d)* The ventral lobe of the female bract is much reduced *(pl. 39, figs. 6 and 7; pl. 41, fig. 3);*

(e) The gemmae have fewer than 24 cells and *(f)* The margin of the gemma is not crenulate but entire.

^{g}**Cololejeunea sicaefolia** Gottsche in Steph., Hedwigia, 27:290, 1888.

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, in packet of *Leucolejeunea xanthocarpa,* May 10, 1932 *(Howell 257).*

^{c}**Cyclolejeunea convexistipa** (Lehm. & Lindenb.) Evans, Bull. Torr. Bot. Club, 31:198, 1904. *(Jungermannia convexistipa* Lehm. & Lindenb. in Lehm., Pugillus, 6:43, 1834.)

Cocos Island, Wafer Bay, in packet of *Cheilolejeunea decidua,* June 28, 1932 *(Howell 227).*

Dendroceros crispus (Swartz) Nees in G. L. & N., Syn. Hep., 581, 1846. *(Anthoceros crispus* Swartz, Prodr. Fl. Ind. Occid., 3:1884, 1806.)

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, in packet of *Omphalanthus filiformis,* May 10, 1932 *(Howell 255).* Known from the Galapagos Islands (Howe, 1934, p. 207).

Dicranolejeunea axillaris (Mont.) Steph., Sp. Hep., 5:163, 1912. *(Lejeunea axillaris* Mont., Ann. Sci. Nat., ser. 2, 5:59, 1836.)

Galapagos Islands, Albemarle Island, Villamil Mountain, common on branches of trees, August 23, 1906 *(Stewart 6760).* Reported from the Galapagos Islands (Stephani 1898–1925, vol. 5, p. 163).

^{r}**Euosmolejeunea duriuscula** (Nees) Evans, Mem. Torr. Bot. Club, 8:135, 1902. *(Lejeunea duriuscula* Nees in G. L. & N., Syn. Hep., 364, 1845.)

Revillagigedo Islands, Socorro Island, March 27, 1932 *(Howell 179).*

^{g}**Euosmolejeunea trifaria** (Nees) Schiffn. in Engler & Prantl, Nat. Pfl. Fam., Ed. 1, 1^{3}:124, 1895. *(Lejeunea trifaria* Nees in G. L. & N., Syn. Hep., 361, 1845.)

Galapagos Islands, Abingdon Island, common on trees, in packet of *Omphalanthus filiformis,* September 21, 1906 *(Stewart 8710);* Indefatigable Island, near Camp No. 1, altitude 1700 feet, May 10, 1932 *(Howell 263).*

***Fossombronia hispidissima** Steph., Sp. Hep., 1:389, 1900.

Guadalupe Island, altitude 2500 feet, March 17, 1932 *(Howell 163).*

Frullania aculeata Tayl., London Journ. Bot., 5:407, 1846.

Galapagos Islands, Duncan Island, on trees and bushes, December 2, 1905 *(Stewart 3166):* Charles Island, common on bushes, October 7, 1905 *(Stewart 765):* Chatham Island, common on bushes, February 26, 1906 *(Stewart 2770):* Indefatigable Island, just below Fortuna, in forest belt, hanging in bunches on branches, May 12, 1932 *(Howell 214).* Known from the Galapagos Islands (Robinson, 1902, p. 100).

Frullania arecae (Spreng.) Spruce, Trans. Bot. Soc. Edinburgh, 15: 20, 1884. *(Jungermannia arecae* Spreng., Neue Entdeck., 2: 99, 1821.)

Galapagos Islands, Albemarle Island, above Santo Tomas, Villamil Mountain, on trees, in packet of *Brachiolejeunea grandidentata,* April 29, 1932 *(Howell 211A),* and of *Frullania atrata (211B).* Reported from the Galapagos Islands as *Frullania hians* Lehm. & Lindenb. (Stephani, 1898–1925, vol. 4, p. 333).

Frullania atrata Nees in G. L. & N., Syn. Hep., 463, 1845.

Galapagos Islands, Albemarle Island, above Santo Tomas, Villamil Mountain, on trees, April 29, 1932 *(Howell 211B, 215),* and in packet of *Brachiolejeunea grandidentata (211A):* Indefatigable Island, near Camp No. 1, altitude 1700 feet, in packet of *Euosmolejeunea trifaria,* May 10, 1932 *(Howell 263);* also near Fortuna, May 12, 1932 *(268),* and in packet of *Frullania riojaneirensis (265A, 265B):* Charles Island, on summit of high peak, on ground and rocks, May 18, 1932 *(Howell 216).* Known from the Galapagos Islands (Robinson, 1902, p. 100, and Robinson and Greenman, 1895, p. 149).

^{g}**Frullania atrosanguinea** Tayl. in Spruce, Trans. Bot. Soc. Edinburgh, 15: 39, 1884.

Galapagos Islands, James Island, common on trees, August 8, 1906 *(Stewart 6064).*

^{g}**Frullania brasiliensis** Raddi, Mem. Soc. Sci. Modena, 19: 36, 1823.

Galapagos Islands, Charles Island, common on rocks, October 9, 1905 *(Stewart 872):* Indefatigable Island, common on trees, October 28, 1905 *(Stewart 1734):* Chatham Island, on rocks and dead twigs, in packet of *Marchesinia brachiata,* January 27, 1906 *(Stewart 2598),* and on bushes and trees, in packet of *Omphalanthus filiformis,* February 23, 1906 *(Stewart 2783):* James Island, common on trees, August 8, 1906 *(Stewart 6063):* Abingdon Island, common on trees, in packet of *Omphalanthus filiformis,* September 21, 1906 *(Stewart 8710).*

Frullania californica (Aust.) Evans, Trans. Conn. Acad. Arts Sci., 10: 25, 1897. *(Frullania asagrayana* var. *californica* Aust. in Underw., Bull. Ill. State Lab. Nat. Hist., 2: 67, 1884; emend. Howe, Erythea, 2: 98, 1894.)

Guadalupe Island, on Pine Ridge, on rocks and trees, November 11, 1931 *(Howell 135).* Reported from Guadalupe under the name *Frullania catalinae* Evans (Sutliffe, 1932).

Frullania cocosensis Steph., Sp. Hep., 4: 492, 1911.

Cocos Island, Wafer Bay, June 28, 1932 *(Howell 226);* male plants only. Known only from Cocos Island (Stephani 1898–1925, vol. 4, p. 492). Apparently Stephani considered Cocos Island one of the Galapagos group.

gc**Frullania cucullata** Lindenb. & Gottsche in G. L. & N., Syn. Hep., 782, 1847.

Galapagos Islands, James Island, on bushes, December 19, 1905 *(Stewart 3394).*

Cocos Island, Wafer Bay, June 28, 1932 *(Howell 229),* and Chatham Bay, in packet of *Taxilejeunea pterogonia,* June 28, 1932 *(228).*

r**Frullania eboracensis** Gottsche in Lehm., Pugillus, 8:14, 1844.

Revillagigedo Islands, Socorro Island, March 27, 1932 *(Howell 178),* and in packet of *Lejeunea cladogyna (170).*

gc**Frullania gymnotis** Nees & Mont. in Mont., Ann. Sci. Nat., ser. 2, 19:257, 1843.

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, in packet of *Leucolejeunea xanthocarpa,* May 10, 1932 *(Howell 257),* and in packet of *Euosmolejeunea trifaria (263).*

Cocos Island, Wafer Bay, in packet of *Lopholejeunea cocosensis,* June 28, 1932 *(Howell 231).*

r***Frullania inflata** Gottsche in G. L. & N., Syn. Hep., 424, 1845.

Revillagigedo Islands, Socorro Island, March 27, 1932 *(Howell 173),* also above Braithwaite Bay, at lower limit of forest *(171),* and in packet of *Lejeunea setiloba (172).*

Guadalupe Island, on Pine Ridge, November 14, 1931 *(Howell 130),* and November 15, 1931 *(131, 141).*

Nicaragua, Gulf of Fonseca, east of Volcano Coseguina, near shore, July 7, 1932 *(Howell 244).*

c**Frullania riojaneirensis** (Raddi) Spruce, Trans. Bot. Soc. Edinburgh, 15:23, 1884. *(Frullanioides riojaneirensis* Raddi, Mem. Soc. Sci. Ital. Modena, 12:37, 1823.)

Galapagos Islands, Indefatigable Island, near Fortuna, May 12, 1932 *(Howell 208, 265A, 265B).* Reported from the Galapagos Islands as *Frullania arietina* (Robinson and Greenman, 1895, p. 149).

Cocos Island, Wafer Bay, in packet of *Cheilolejeunea decidua,* June 28, 1932 *(Howell 277).*

r**Frullania riparia** Hampe in Lehm., Pugillus 7:14, 1838.

Revillagigedo Islands, Socorro Island, in packet of *Euosmolejeunea duriuscula,* March 27, 1932 *(Howell 179).*

Nicaragua, Gulf of Fonseca, east base of Volcano Coseguina, near shore, in packet of *Lejeunea setiloba,* July 7, 1932 *(Howell 246).*

g**Frullania squarrosa** (R., Bl. & Nees) Dum., Rec. d'Obs., 13, 1835.

(Jungermannia squarrosa R. Bl. & Nees, Nova Acta Acad. Caes. Leop-Carol., 12: 219, 1824.)

Galapagos Islands, Charles Island, east of highest cone, April 25, 1932 *(Howell 191)*, and inland from Postoffice Bay, on rocks, July 17, 1932 *(186)*: Indefatigable Island, Academy Bay, on stumps, May 2, 1932 *(Howell 192)* and May 4, 1932 *(207)*: Albemarle Island, Iguana Cove, May 21, 1932 *(Howell 200)*.

Nicaragua, Gulf of Fonseca, east of Volcano Coseguina, in packet of *Lejeunea setiloba*, July 7, 1932 *(Howell 270)*.

Mexico, Tres Marias Islands, Maria Madre Island, July 26, 1932 *(Howell 237)*.

^{gcr}**Lejeunea cladogyna** Evans, Amer. Journ. Bot., 5: 134, 1918.

Galapagos Islands, James Island, common on trees, August 8, 1906 *(Stewart 6066)*: Charles Island, in packet of *Plagiochila asplenioides*, April 25, 1932 *(Howell 189)*: Indefatigable Island, near Fortuna, May 10, 1932 *(Howell 266)*, and in packet of *Stylolejeunea pililoba*, May 8, 1932 *(267)* and of *Plagiochila bursata (284)*.

Cocos Island, Chatham Bay, June 28, 1932 *(Howell 233)*, and Wafer Bay, in packet of *Lopholejeunea cocosensis (231)*.

Revillagigedo Islands, Socorro Island, March 27, 1932 *(Howell 170)*, and in packet of *Lejeunea setiloba (172)*.

^{gc}**Lejeunea flava** (Swartz) Nees, Naturg. Eur. Leberm., 3: 277, 1838. *(Jungermannia flava* Swartz, Prodr. Fl. Ind. Occid., 144, 1788.)

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, in packet of *Ceratolejeuna maritima*, May 10, 1932 *(Howell 251)*, and in packet of *Leucolejeunea xanthocarpa (257)*: Charles Island, summit of high peak, on ground and rocks, in packet of *Frullania atrata*, May 10, 1932 *(Howell 216)*.

Cocos Island, Wafer Bay, in packet of *Frullania cucullata*, June 28, 1932 *(Howell 229)*.

^{gcr}**Lejeunea setiloba** Spruce, Trans. Bot. Soc. Edinburgh, 15 :281, 1884.

Galapagos Islands, Indefatigable Island, near Camp No. 1, in packet of *Plagiochila bursata*, May 10, 1932 *(Howell 248)*.

Cocos Island, Wafer Bay, in packet of *Lopholejeunea cocosensis*, June 28, 1932 *(H. Walton Clark 221)*.

Revillagigedo Islands, Socorro Island, March 27, 1932 *(Howell 172)*.

Nicaragua, Gulf of Fonseca, east of Volcano Coseguina, July 7, 1932 *(Howell 242, 246, 270)*.

^{g}**Leucolejeunea xanthocarpa** (Lehm. & Lindenb.) Evans, Torreya, 7:229, 1907. *(Jungermannia xanthocarpa* Lehm. & Lindenb. in Lehm., Pugillus, 5:8, 1832.

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, May 10, 1932 *(Howell 257)*, also in packet of *Ceratolejeunea maritima (251)* and of *Euosmolejeunea trifaria (263)*.

Lophocolea bidentata (L.) Dum., Rec. d'Obs., 17, 1835. *(Jungermannia bidentata* L., Sp. Pl. 1132, 1753.)

Guadalupe Island, Pine Ridge, on rocks, November 15, 1931 *(Howell 137)*. Known from Guadalupe (Sutliffe, 1932).

^{c}**Lopholejeunea cocosensis** Clark, new species.

Plants large, in closely appressed mats or mixed with other lejeunoid species, dark brown or olive-green to light green, glossy; leafy shoots up to 2.2 mm. wide. Stems prostrate, irregularly 2–3-pinnate, up to 227 μ in diameter and 3 cm. long; in cross section the cortical layer of a single row of cells; cortical cells larger, tangentially about 34 μ and radially about 18 μ, with walls pigmented; interior cells distinctly smaller, roundish-hexagonal, colorless. Leaves imbricate, widely spreading; keel more or less convex. Dorsal leaf lobe plane or very slightly convex, ovate-oblong, slightly falcate, 3.4–4 mm. long from insertion, 0.8–1.4 mm. wide; apex rounded, slightly decurved; margin entire to occasionally sinuate at dorsal base; dorsal margin arching to middle of stem or to stem-width over it; ventral margin forming an obtuse angle with the keel. Ventral lobes of leaf well developed, ovate, about 234 μ long and 180 μ wide, inflated except at apex; inflated portion hemispheric, conspicuous, constituting a swelling at inner half of the ventral lobe; apical tooth triangular, its base 2 cells wide and 2–3 cells (about 42 μ) long; sinus narrow, adnate portion 2–3 cells long; margin of free portion entire; hyaline papilla on incurved margin of ventral lobe. Cells of dorsal leaf lobe slightly bulging on dorsal surface, marginal ones about 17 μ, median 25 μ, basal 51 × 34 μ; trigones distinct but not bulging; walls uniformly somewhat thickened, pits small; intermediate thickenings common, oval. Underleaves imbricate, reniform, very large but smaller than the dorsal leaf lobe, 532–770 μ long, 1.3–1.45 mm. wide; base rounded to subcordate; apex broad, rounded; margin entire. Plants bisexual. Male inflorescence an oblong branch; bracts 8–12, unequally 2-lobed, strongly concave; ventral lobe the smaller, more convex dorsally; both lobes with apex rounded and margins entire. Male bracteoles imbricate, orbicular to broader than long. Female inflorescence on a short to long branch. Female bract widely spreading, 2-lobed to below middle. Dorsal lobe falcate, broadly ovate-orbicular to ovate, about 1.56 mm. long and 780 μ wide; apex obtuse to rounded, apiculate; dorsal margin with 6–9 coarse irregular teeth in upper part, basal half entire; ventral margin dentate; its teeth to 4 cells long, 2–4 cells wide at base, blunt or sharp. Ventral lobe large, about 710 μ long and 284 μ wide, more or less concavely folded on dorsal lobe; apex acute to apiculate, margins coarsely dentate, with a large curved tooth at base of sinus (fig. 7). Female bracteole free, large, orbicular to slightly longer than wide, about 1.3 mm. long and 1.1 mm. wide; apex rounded, recurved; margins coarsely dentate; teeth numerous, short to 2–4 cells long, 2–3 cells wide at base. Perianth ovate to obovate, extending slightly beyond the bracts, about 3 mm. long and 805 μ wide at middle, with plane dorsal face; keels 4, 2 lateral, 2 ventral; lateral keels deeply and coarsely laciniate; laciniae more or less curved, crowded, ovate to lanceolate from a narrow base, acute, entire; beak short.

Plantae maximae, subnigrae fuscae, viridi-nigricantes aut pallentes, nitidae. Caules procumbentes inaequali-pinnati. Folia imbricata, bilobata; lobo dorsali plano, oblongo-ovato, 3.4–4 mm. longo, 0.8–1.4 mm. lato; apice rotundato, decurvato; marginibus integerrimis aut sinuatis a basi dorsali; lobo ventrali ovato, 234 μ longo, 180 μ lato, parte inflata hemisphaericali conspicua; dente apicali triangulari a basi 2 cellulas lato, 2–3 cellulas longo; sinu angusto; margine partis solutae integerrimo. Amphigastria maxima imbricata reniformia, apice lato, rotundato, marginibus integris, basi rotundata aut subcordata. Plantae dioeciae. Folia floralia bilobata; lobo dorsali falcato ovato-orbiculato aut ovato 1.56 mm. longo, 780 μ lato; apice obtuso aut rotundato apiculato; parte superiore marginis dorsalis cum 6–9 dentibus crassis, parte a basi integerrima; margine ventrali dentato cum dentibus 4 cellas longis, a basi 2–4 cellas lato; lobo ventrali magno in lobum dorsalem concave plicato; apice acuto aut apiculato; marginibus crasse dentatis et uno magno dente curvato a basi sinus. Amphigastria floralia soluta, maxima, orbiculata aut longioria quam latioria; apice rotundato recurvato; marginibus cum multis dentibus crassis, 2–4 cellas longis, a basi 2–3 cellas latis. Perianthium ovatum aut obovatum, 4 carinis; marginibus carinarum alte et crasse laciniatis; rostro brevi. Androecia a ramo brevi; foliis masculinis 4–6 jugis, inaequaliter bilobatis.

Cocos Island, Wafer Bay, June 28, 1932 *(John Thomas Howell 231, type,* Herb. Calif. Acad. Sci. no. 372, 427), and in packet of *Frullania cucullata (229),* also intermingled with other hepaticae in packet of *Lopholejeunea cocosensis (H. Walton Clark 221).*

Lopholejeunea cocosensis is near *L. sagraeana,* the vegetative characters offer no distinct separation. However, in the former: *(a)* The dorsal lobe of the female bract often is apiculate; *(b)* The ventral lobe of the female bract is approximately 1 mm. long and wide; *(c)* The margins of the bracteole are coarsely dentate; *(d)* The laciniae on the margins of the lateral keels of the perianth are entire. In the latter: *(a)* The dorsal lobe of the female bract is obtuse or acute; *(b)* The ventral lobe of the female bract is reduced to a mere tooth; *(c)* The margins of the bracteole are entire or merely vaguely sinuate; *(d)* The laciniae on the margins of the lateral keels of the perianth are irregularly dentate or spinose-dentate.

c**Lopholejeunea muelleriana** (Gottsche) Schiffn., Bot. Jahrb., 23: 599, 1897. *(Lejeunea muelleriana* Gottsche, Kongl. Danske Vidensk. Selsk. Skrift., ser. 5, 6: 280, 1867.)

Cocos Island, Wafer Bay, June 28, 1932 *(Howell 241)*, and in packet of *Frullania cocosensis (226)*, and of *Symbiezidium vincentianum (222)*; also Chatham Bay, in packet of *Symbiezidium pogonopterum (225)*.

g**Lophozia opacula** (Spruce) Steph., Sp. Hep., 2:46, 1901. *(Jungermannia opacula* Spruce, Trans. Bot. Soc. Edinburgh, 15:514, 1885.)

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, in packet of *Cheilolejeunea decidua*, May 10, 1932 *(Howell 256)*.

Marchesinia brachiata (Swartz) Schiffn. in Engler & Prantl, Nat. Pfl. Fam., Ed. 1, 1^3: 128, 1895. *(Jungermannia brachiata* Swartz, Prodr. Fl. Ind. Occid., 144, 1788.)

Galapagos Islands, Chatham Island, common on moist rocks and dead twigs, January 27, 1906 *(Stewart 2598, 4042)*: Indefatigable Island, Camp No. 1, altitude 1700 feet, May 10, 1932 *(Howell 250)*. Known from the Galapagos Islands (Robinson, 1902, p. 101, and Evans, 1907, p. 548).

g**Mastigolejeunea auriculata** (Wils. & Hook.) Schiffn. in Engler & Prantl, Nat. Pfl. Fam., Ed. 1, 1^3: 129, 1895. *(Jungermannia auriculata* Wils. & Hook., Musci Amer. Exsic., 170, 1841.)

Galapagos Islands, Indefatigable Island, near Fortuna, in packet of *Frullania riojaneirensis*, May 12, 1932 *(Howell 265B)*, and of *Frullania atrata (268)*.

Metzgeria grandiflora Evans, Torreya, 16:68, 1916.

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, in packet of *Microlejeunea ulicina*, May 10, 1932 *(Howell 249)* and of *Plagiochila bursata (264)*. Known from the Galapagos Islands (Evans, 1916, p. 68).

gc**Microlejeunea bullata** (Tayl.) Evans, Mem. Torr. Bot. Club, 8: 164, 1902. *(Lejeunea bullata* Tayl., London Journ. Bot., 5:398, 1846.)

Galapagos Islands, Albemarle Island, top of Tagus Cove Mountain, altitude about 4000 feet, May 26, 1932 *(Howell 218)*.

Cocos Island, Wafer Bay, in packet of *Cheilolejeunea decidua*, June 28, 1932 *(Howell 227)*.

^{gr}**Microlejeunea laetevirens** (Nees & Mont.) Evans, Bryologist, 11:68, 1908. *(Lejeunea laetevirens* Nees & Mont. in Ramon de la Sagra, Hist. Fis. Pol. y Nat. Cuba, 9:281, 1845.)

Galapagos Islands, Indefatigable Island, near Fortuna, in packet of *Plagiochila martiana,* May 12, 1932 *(Howell 269).*

Revillagigedo Islands, Socorro Island, in packet of *Frullania eboracensis,* March 27, 1932 *(Howell 178).*

^{g}**Microlejeunea ulicina** (Tayl.) Evans, Mem. Torr. Bot. Club, 8:165, 1902. *(Jungermannia ulicina* Tayl., Trans. Bot. Soc. Edinburgh, 1:115 1844.)

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, May 10, 1932 *(Howell 249).*

Omphalanthus filiformis (Swartz) Nees in G. L. & N., Syn. Hep. 304, 1845. *(Jungermannia filiformis* Swartz, Prodr. Fl. Ind. Occid., 144, 1788.)

Galapagos Islands, James Island, on trees, August 8, 1906 *(Stewart 6044),* and on bushes, in packet of *Frullania cucullata,* December 19, 1905 *(3394):* Chatham Island, on bushes and trees, February 23, 1906 *(Stewart 2783):* Abingdon Island, common on trees, September 21, 1906 *(Stewart 8710):* Albemarle Island, above Santo Tomas, Villamil Mountain, on trees, in packet of *Brachilejeunea grandidentata,* April 29, 1932 *(Howell 211A):* Indefatigable Island, Camp No. 1, altitude 1700 feet, May 10, 1932 *(Howell 255):* Charles Island, summit of high peak, on ground and rocks, in packet of *Frullania atrata,* May 18, 1932 *(Howell 216).* Known from the Galapagos Islands (Robinson, 1902, p. 101).

^{g}**Peltolejeunea jackii** Steph., Hedwigia, 31:18, 1892.

Galapagos Islands, James Island, on bushes, in packet of *Frullania cucullata,* December 19, 1905 *(Stewart 3394):* Abingdon Island, common on trees, in packet of *Omphalanthus filiformis,* September 21, 1906 *(Stewart 8710).*

Plagiochasma rupestre (Forst.) Steph., Sp. Hep., 1:80, 1898. *(Aytonia rupestris* Forst., Char. Gen. Plant., 147, 1776.)

Galapagos Islands, Albemarle Island, Iguana Cove, May 21, 1932 *(Howell 194),* and Tagus Cove Mountain, west side, altitude 1500 feet, in moist shaded places under rocks *(198):* Charles Island, east of highest cone, April 25, 1932 *(Howell 210),* and at "The Springs," on wet rocks *(217).* Known from the Galapagos Islands (Evans, 1915, p. 280).

Plagiochila anderssonii Angstr., Kongl. Vetensk.-Akad. Föhr., 114, 1873.

Cocos Island, Wafer Bay, June 28, 1932 *(Howell 232),* and in packet of

Lopholejeunea muelleriana (241). Known from the Galapagos Islands (Robinson, 1902, pp. 101 and 241), and from Cocos Island (Evans, 1907, pp. 101 and 261; Stephani, 1898–1925, vol. 2, p. 497; Robinson, 1902, p. 261).

g**Plagiochila asplenioides** (L.) Dum. Rec. d'Obs., 14, 1835. *(Jungermannia asplenioides* L., Sp. Pl. 1131, 1783.)

Galapagos Islands, Charles Island, in packet of *Lejeunea cladogyna,* April 25, 1932 *(Howell 189),* and summit of high peak, on ground and rocks, in packet of *Frullania atrata,* May 18, 1932 *(216).*

g**Plagiochila breuteliana** Lindenb. in Lindenb. & Gottsche, Sp. Hep., 150, yr. ?.

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, in packet of *Ceratolejeunea maritima,* May 10, 1932 *(Howell 260).*

gc**Plagiochila bursata** (Desv.) Lindenb. in Lindenb. & Gottsche, Sp. Hep., 88, yr. ?. *(Jungermannia bursata* Desv., Jour. de Bot., 4:59, 1824.)

Galapagos Islands, Indefatigable Island, at Fortuna, May 8, 1932 *(Howell 284);* at Camp No. 1, altitude 1700 feet *(248, 261, 264),* also in packet of *Microlejeunea ulicina (249),* of *Ceratolejeunea maritima (252),* of *Cheilolejeunea decidua (256),* of *Euosmolejeunea trifaria (263)* and of *Taxilejeunea pterogonia (253B):* Charles Island, summit of high peak, on ground and rocks, in packet of *Frullania atrata,* May 18, 1932 *(Howell 216).*

Cocos Island, Wafer Bay, in packet of *Symbiezidium transversale,* June 28, 1932 *(H. Walton Clark 230),* and in packet of *Lopholejeunea cocosensis (221);* Chatham Bay, in packet of *Taxilejeunea pterogonia,* June 28, 1932 *(Howell 228).*

gc**Plagiochila martiana** Nees in Lindenb. & Gottsche, Sp. Hep., 12, 1839. *(Jungermannia martiana* Nees, Linnaea, 6: 617, 1831.)

Galapagos Islands, Indefatigable Island, on trees, November 9, 1905 *(Stewart 386),* and near Fortuna, May 12, 1932 *(Howell 269):* James Island, on trees, January 3, 1906 *(Stewart 3404, 3660),* and in packet of *Lejeunea cladogyna,* August 8, 1906 *(6066).*

Cocos Island, Chatham Bay, in packet of *Symbiezidium pogonopterum,* June 28, 1932 *(Howell 225).*

Porella navicularis (Lehm. & Lindenb.) Lindb., Acta Soc. Sci. Fennica, 9: 337, 1869. *(Jungermannia navicularis* Lehm. & Lindenb. in Lehm., Pugillus, 6: 37, 1834.)

Guadalupe Island, on trees and rocks in Pine Forest, November 15, 1931 *(Howell 133, 136).* Reported from Guadalupe (Sutliffe, 1932).

c**Radula affinis** Lindenb. & Gottsche in G. L. & N., Syn. Hep., 725, 1847.

Cocos Island, Wafer Bay, in packet of *Lopholejeunea cocosensis,* June 28, 1932 *(H. Walton Clark 221),* and of *Symbiezidium transversale (230);* also in packet of *Symbiezidium vincentinum,* June 28, 1932 *(Howell 222)* and of *Frullania cucullata (229).*

[g]**Rectolejeunea maxonii** Evans, Bull. Torr. Bot. Club, 39: 609, 1912.

Galapagos Islands, Albemarle Island, above Santo Tomas, Villamil Mountain, on trees, in packet of *Brachiolejeunea grandidentata,* April 29, 1932 *(Howell 211A).*

Sphaerocarpus cristatus Howe, Mem. Torr. Bot. Club, 7: 66, 1899.

California, San Nicolas Island, March 13, 1932 *(Howell 148).*

[c]**Stictolejeunea squamata** (Willd.) Schiffn. in Engler & Prantl, Nat. Pfl. Fam., Ed. 1, 1^3: 131, 1895.

Cocos Island, Chatham Bay, June 28, 1932 *(Howell 223).*

[g]**Stylolejeunea pililoba** (Spruce) Evans, Bryologist, 43: 3, 1940. *(Lejeunea pililoba* Spruce, Journ. Linn. Soc. Bot., 30: 346, 1895.)

Galapagos Islands, Indefatigable Island, near Fortuna, May 8, 1932 *(Howell 267).*

Symbiezidium pogonopterum (Spruce) Steph., Sp. Hep., 5: 103, 1912. *(Lejeunea pogonoptera* Spruce, Trans. Bot. Soc. Edinburgh, 15: 128, 1884.)

Cocos Island, Chatham Bay, June 28, 1932 *(Howell 225).* Known from Cocos Island (Robinson, 1902, p. 261) as *Platylejeunea pogonoptera.*

[gc]**Symbiezidium transversale** (Swartz) Trev., Mem. Soc. Istit. Lomb., III. 4: 403, 1877. *(Jungermannia transversalis* Swartz, Prodr. Fl. Ind. Occid., 144, 1788.)

Galapagos Islands, Charles Island, east of the highest cone, April 25, 1932 *(Howell 190).*

Cocos Islands, Wafer Bay, June 28, 1932 *(H. Walton Clark 230),* and in packet of *Lopholejeunea cocosensis (Howell 231).*

[c]**Symbiezidium vincentinum** (Gottsche) Trev., Mem. Istit. Lomb., III. 4: 403, 1877. *(Lejeunea vincentina* Gottsche in G. L. & N., Syn. Sep., 313, 1845.)

Cocos Island, Wafer Bay, June 2, 1932 *(Howell 222).*

[g]**Syzygiella oppositifolia** Spruce in Gepp., Hep. Domin., Journ. of Bot., :302, 1895. *(Jungermannia oppositifolia* Spruce, Mem. Torr. Bot. Club, 1: 138, 1890.)

Galapagos Islands, Chatham Island, on rocks and soil, July 6, 1906 *(Stewart 7330).*

Targionia hypophylla L., Sp. Pl., 1604, 1753.

Guadalupe Island, above northeast anchorage on slopes, November 14, 1931 *(Howell 132, 143),* and in packet of *Asterella californica (129);* also on north end of the island, March 16, 1932 *(Howell 161).* Known from Guadalupe (Sutliffe, 1932).

California, San Nicolas Island, March 13, 1932 *(Howell 150, 151).*

^{gc}**Taxilejeunea pterogonia** (Lehm. & Lindenb.) Schiffn. in Engler & Prantl Nat. Pfl. Fam., Ed. 1, 1^3: 125, 1895. *(Jungermannia Pterogonia* Lehm. & Lindenb. in Lehm., Pugillus, 6 : 44, 1834.)

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, May 10, 1932 *(Howell 253A, 253B).*

Cocos Island, Wafer Bay, June 28, 1932 *(Howell 224),* and Chatham Bay *(228).*

^{g}**Telaranea nematodes** (Aust.) Howe, Bull. Torr. Bot. Club, 29 : 284, 1902. *(Cephalozia nematodes* Aust., Bull. Torr. Bot. Club, 6 : 302, 1879.)

Galapagos Islands, Indefatigable Island, Camp No. 1, altitude 1700 feet, in packet of *Calypogeia miquelii,* May 10, 1932 *(Howell 254)* and of *Cheilolejeunea decidua (256).*

ADDITIONAL SPECIES REPORTED

Species not in this collection but reported from the Galapagos, Cocos, Revillagigedo, or Guadalupe islands. We have not the literature to make this list complete.

Anthoceros simulans Howe. Galapagos (Howe, 1934, p. 204).

Anthoceros vegetans Howe. Cocos (Howe, 1934, p. 206).

Brachiolejeunea galapagona (Angstr.) Steph. Galapagos (Stephani, 1898–1925, vol. 5 (1912), p. 139).

Frullania decipiens (Beauv.) Steph. Galapagos and Cocos (Stephani, 1898–1925, vol. 6, p. 570 and vol. 4, p. 532).

Frullania galapagona Angstr. Galapagos (Stephani, 1898–1925, vol. 4, p. 636).

Frullania tamarisci (L.) Dum. Galapagos (Robinson, 1902, p. 100).

Frullania vaginata (Swartz) Dum. Galapagos (Robinson, 1902, p. 100).

Hygrolejeunea ocellata Steph. Cocos (Stephani, 1898–1925, vol. 5, p. 566).

Lopholejeunea anderssonii Steph. Galapagos (Robinson, 1902, p. 100; Stephani, 1896, p. 108; Stephani, 1898–1925, vol. 5, p. 76).

Macrolejeunea subsimplex (Mont.) Schiffn. Cocos (Robinson, 1902, p. 261).

Marchantia chenopoda L. Galapagos (Evans, 1917, p. 295).

Marchesinia galapagona (Angstr.) Steph. Galapagos (Stephani, 1898–1925, vol. 5, p. 146).

Marchesinia nigrescens (Angstr.) Steph. Galapagos (Stephani, 1898–1925, vol. 5, p. 146).

Notothylas galapagensis Howe. Galapagos (Howe, 1934, p. 304).

Peltolejeunea galapagona Steph. Galapagos (Robinson, 1902, p. 101; Stephani, 1898–1925, vol. 4, p. 700).

Plagiochila ovata Lindenb. & Gottsche. Galapagos (Stephani, 1898–1925, vol. 2, p. 578).

Plagiochila spinifera Angstr. Galapagos (Robinson, 1902, p. 101; Stephani, 1898–1925, vol. 2, p. 593).

Plagiochila subsimplex Steph. Galapagos (Stephani, 1898–1925, vol. 2, p. 233).

Plagiochila trifida Steph. Galapagos (Stephani, 1898–1925, vol. 6, p. 232).

Radula galapagona Steph. Galapagos (Stephani, 1898–1925, vol. 4, p. 176).

Radula retroflexa Tayl. Galapagos (Robinson, 1902, p. 101; Stephani, 1898–1925, vol. 4, p. 229).

Riccia howellii Howe. Galapagos (Howe, 1934, p. 202).

Riccia iodocheila Howe. Galapagos (Howe, 1934, p. 200).

Riccia mauryana Steph. Guadalupe (Sutliffe, 1932).

Riccia nigrella DC. Guadalupe (Howe, 1934, p. 200).

Riccia sorocarpa Bisch. Guadalupe (Howe, 1934, p. 199; Sutliffe, 1932).

Ricca trichocarpa Howe. Guadalupe (Howe, 1934, p. 200; Sutliffe, 1932).

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PLATE 37

Brachiolejeunea grandidentata

Fig. 1. Base of leaf lobe, x 300.

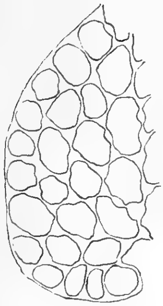
Fig. 2. Female inflorescence, ventral view, *(b)* bracts, *(o)* bracteole, *(w)* wing, x 23.

Fig. 3. Cells half way between margin and middle of leaf lobe, x 400.

Figs. 4–6. Teeth of 3 lobules, x 67.

Fig. 7. Part of plant, ventral view, x 23.

Fig. 8. Two teeth of a leaf lobule, the distal one at the right, *(h)* hyaline papilla, x 300.



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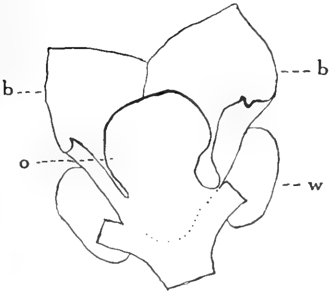

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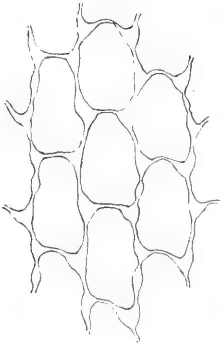

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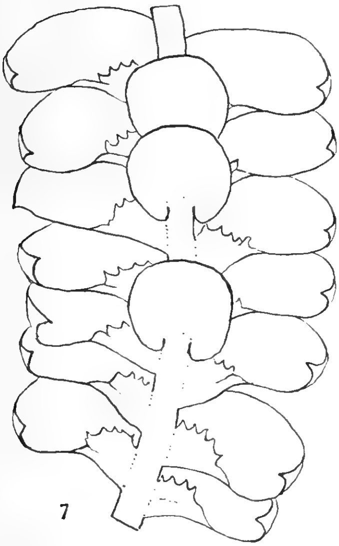

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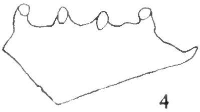

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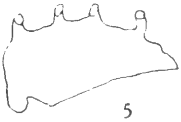

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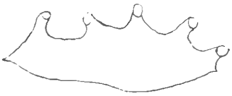

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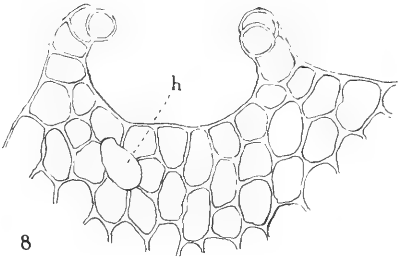

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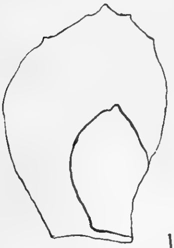
PLATE 38

Ceratolejeunea lobata

Figs. 1–3. Bracts, x 67.
Fig. 4. Bracteole, x 67.
Figs. 5–7. Apices of leaf lobes, x 300.
Fig. 8. Apex of lobule, *(h)* hyaline papilla, x 300.
Fig. 9. Underleaf, x 300.
Fig. 10. Part of plant, ventral view, x 52.
Fig. 11. Cells from base of leaf lobe, paracysts shaded, x 300.
Fig. 12. Underleaf, region of rhizoids shaded, x 300.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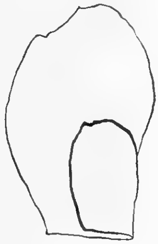
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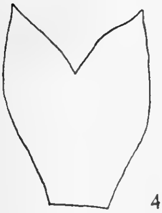
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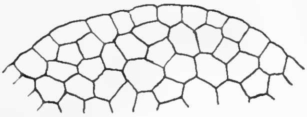
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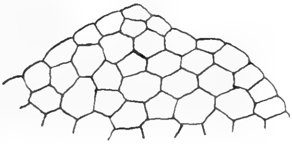
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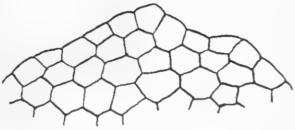
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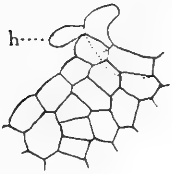

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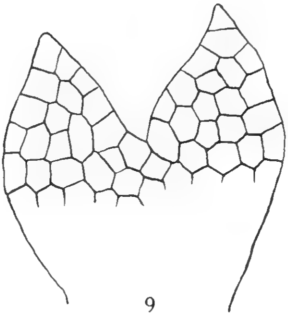
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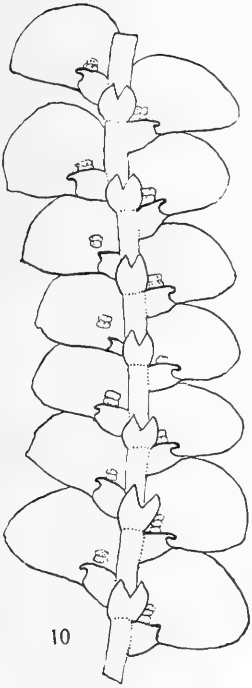
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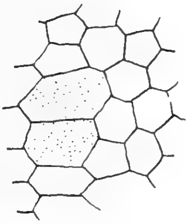
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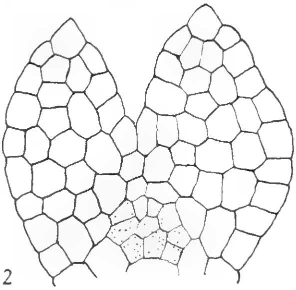
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Plate 39

Cololejeunea coseguinana

Fig. 1. Gemma, x 400.

Fig. 2. Cross section of stem, x 400.

Fig. 3. Base of lobule, *(h)* hyaline papilla, x 300.

Fig. 4. Cross section of seta, x 300.

Fig. 5. Apex of leaf lobe, x 300.

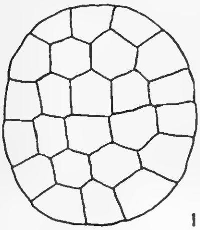
Figs. 6–7. Bracts, *(u)* tip of lobule, x 67.

Fig. 8. Apex of lobule of leaf lobe, *(h)* hyaline papilla, x 300.

Fig. 9. Part of plant, ventral view, x 67.

Fig. 10. Apex of lobule of bract, *(h)* hyaline papilla, x 300.

All drawings made from the type.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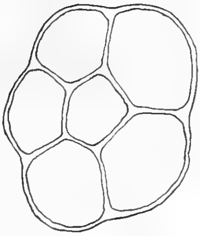
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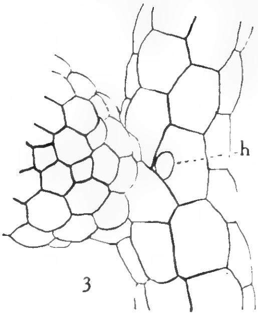

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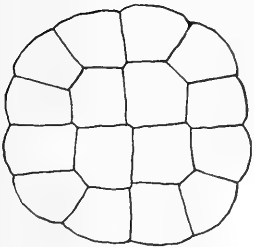
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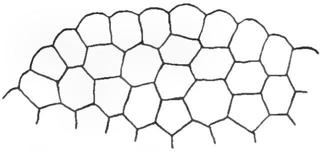
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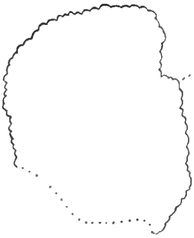
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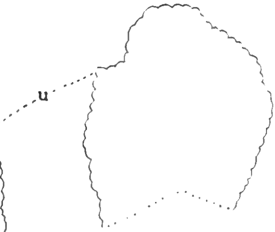

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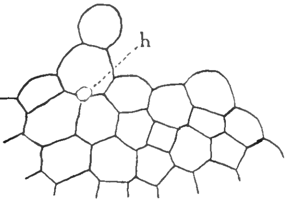

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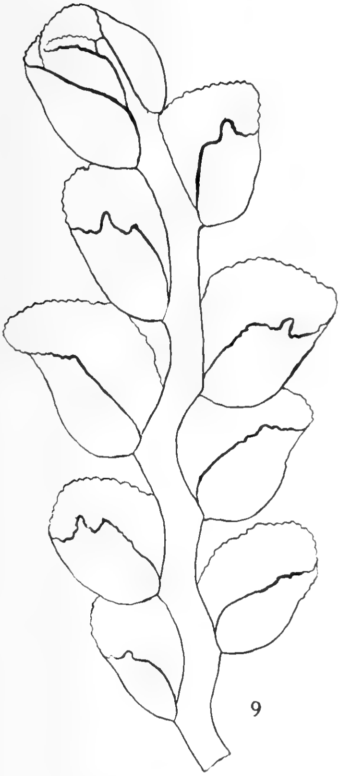
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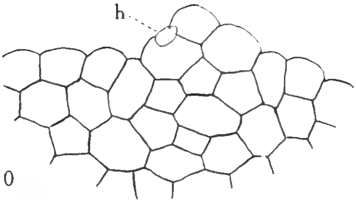

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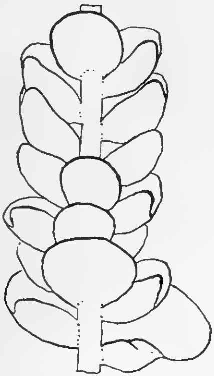
PLATE 40

Lopholejeunea cocosensis

Fig. 1. Male inflorescence, ventral view, x 23.
Fig. 2. Bracteole, x 23.
Fig. 3. Teeth from side of bracteole, x 300.
Fig. 4. Cross section of seta, x 400.
Fig. 5. Bract, x 23.
Fig. 6. Cells from base of leaf lobe, x 400.
Fig. 7. Female inflorescence, ventral view, *(c)* curved tooth of sinus, x 23.
Fig. 8. Bract, x 23.
Fig. 9. Leaves, dorsal view, x 23.
Fig. 10. Part of plant, ventral view, x 23.
Fig. 11. Cross section of stem, x 300.
Fig. 12. Apical region of lobule, *(h)* hyaline papilla, x 300.



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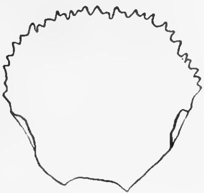

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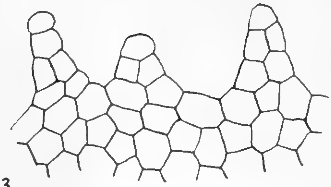

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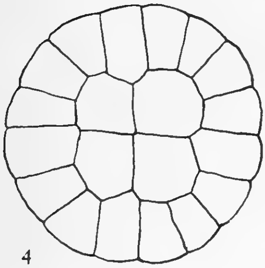

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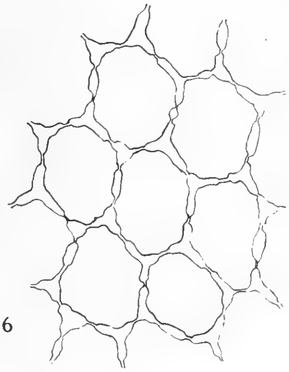

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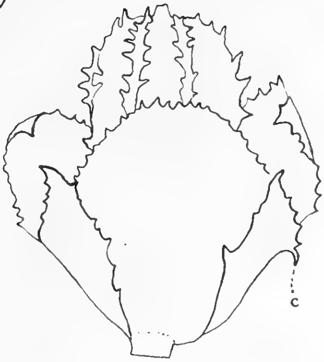

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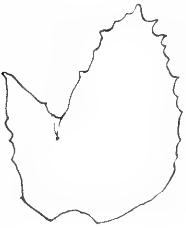

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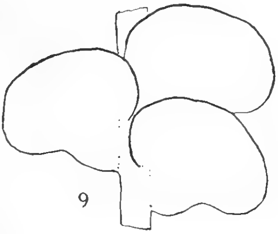

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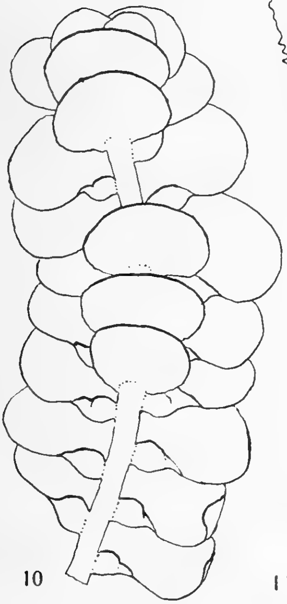

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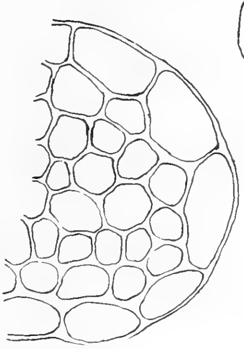

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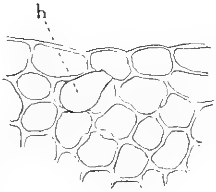

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PLATE 41

Cololejeunea minutissima, from Italy and identified by Spruce

Fig. 1. Apex of leaf lobe, x 300.

Fig. 2. Apex of ventral lobe of leaf, x 300.

Fig. 3. Upper portion of ventral lobe of female bract, *(h)* hyaline papilla, x 300.

Cololejeunea myriocarpa (Nees & Mont.) Steph.

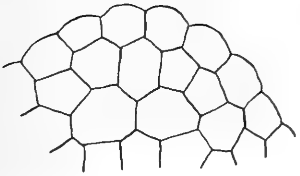
Fig. 4. Apex of leaf lobe, x 300.

Lopholejeunea cocosensis

Fig. 13. Apex of ventral leaf lobe, x 300.

Figs. 14–15. Underleaves near female bracteole, x 23.

Fig. 16. Apical region of ventral leaf lobe, *(h)* hyaline papilla, x 300.



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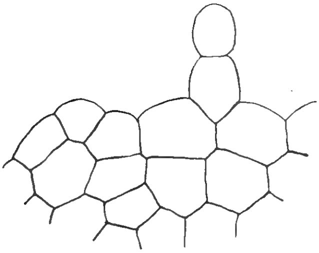

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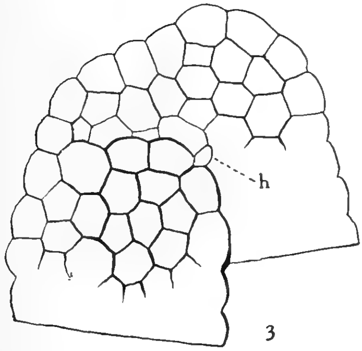

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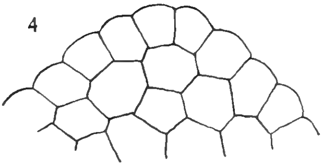

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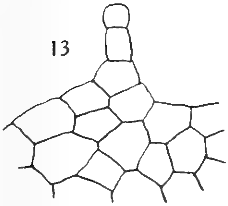

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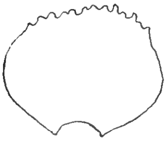

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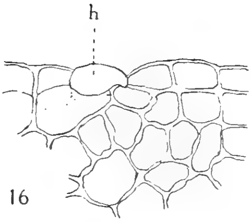

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New names in **bold-face** type

ERRATA

Page 100. Line 24 from top: for *rufumarginatus* read *rufomarginatus.*
Page 177. Publication date: for January 15 read February 7.
Page 470. Line 3 from top: for *Laccoptena* read *Laccoptera.*
Page 593. Bottom line: for *Cytolejeunea* read *Cyclolejeunea.*
Page 612. Bottom line: for *Ricca* read *Riccia.*

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BY

G DALLAS HANNA

No. 10, pp. 359–374, plates 15–19 July 11, 1952

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