



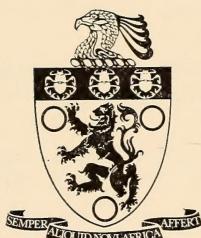


ANNALS OF THE
SOUTH AFRICAN MUSEUM

VOLUME 60

ANNALS OF THE SOUTH AFRICAN MUSEUM
ANNALE VAN DIE SUID-AFRIKAANSE MUSEUM

VOLUME 60



THE TRUSTEES OF THE
SOUTH AFRICAN MUSEUM
CAPE TOWN

DIE TRUSTEES VAN DIE
SUID-AFRIKAANSE MUSEUM
KAAPSTAD

1972-1973

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507.68

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CAPE TOWN

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Volume **60** Band
November **1972** November
Part **1** Deel



THE ORIGIN, INTERRELATIONSHIPS
AND DISTRIBUTION OF SOUTHERN AFRICAN
RAJIDAE (CHONDRICHTHYES, BATOIDAE)

By
P. A. HULLEY

Cape Town Kaapstad

The ANNALS OF THE SOUTH AFRICAN MUSEUM

are issued in parts at irregular intervals as material
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Die ANNALE VAN DIE SUID-AFRIKAANSE MUSEUM

word uitgegee in dele op ongerekende tye na beskikbaarheid
van stof

Verkrygbaar van die Suid-Afrikaanse Museum, Posbus 61, Kaapstad

OUT OF PRINT/UIT DRUK

1, 2(1, 3, 5, 7-8), 3(1-2, 5, t.-p.i.), 5(1-2, 5, 7-9),
6(1, t.-p.i.), 7(1-3), 8, 9(1-2), 10(1),
11(1-2), 5, 7, t.-p.i.), 24(2), 27, 31(1-3), 33

Price of this part/Prys van hierdie deel

R7.50

Trustees of the South African Museum © Trustees van die Suid-Afrikaanse Museum
1972

ISBN 0 949940 15 1

Printed in South Africa by
The Rustica Press, Pty., Ltd,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

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P. A. HULLEY

South African Museum, Cape Town

(With 59 figures and 4 tables)

[*Ms. accepted 27 March 1972*]

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INTRODUCTION

Skates, which show the greatest species diversity among elasmobranch fishes, are included in the family Rajidae, and are characterized by their dorso-ventrally flattened, rhomboidal disc, moderately slender tail, usually with two dorsal fins and a membranous caudal fin, and lack of serrate tail spines. Although they are regularly taken in bottom trawls, together with stockfish (*Merluccius capensis*), kingklip (*Genypterus capensis*), jacopever (*Helicolenus dactylopterus*) and monkfish (*Lophius piscatorius*), they form a small proportion of the total catch (0,001–0,075%) by South African commercial trawlers, and their landed weight has shown a sharp decline from 131 814 lb in 1963 to 14 199 lb in 1965 (Division of Sea Fisheries Report, 1968).

In order to clarify the position of the Rajidae within the southern African ichthyofaunal complex, a research programme was instigated by Dr F. H. Talbot, formerly of the South African Museum, to investigate the systematics, distribution and phylogeny of the group. Hulley (1966, 1969, 1970) has revised the Rajidae of the west and south coasts of southern Africa, at the species level, while Wallace (1967) has investigated the east coast species. From this, it appears that natural relationships between the species are evident, suggesting a regrouping of the *Raja* species at the generic or subgeneric level.

Because of difficulties associated with individual variation, Ishiyama (1952, 1958, 1968) adopted a new approach to rajid systematics, employing characteristics of the clasper, structure of the neurocranium, number of

intestinal valves and valves in the *conus arteriosus*, and the vertebral count, as well as standard morphometric procedures, and has established several new genera and subgenera. Stehmann (1970) has followed this method, supplemented by investigations on the ampullae of Lorenzini and number of pseudo-branchial folds in the spiracle, and has proposed 6 subgenera within the genus *Raja* in the eastern North Atlantic. It appears, however, that of these characters only the anatomy of the clasper, shape of the skull and rostral cartilages, and vertebral count prove to be definite key characters.

These methods have been adopted in this investigation, not only for comparison of southern African species with their European counterparts, but also for establishing interrelationships within the family and the possible origin of the southern African rajid fauna.

The scheme of classification followed in this paper is that of Bigelow & Schroeder (1953).

This work formed part of a thesis submitted for the degree of Ph.D. at the University of Cape Town in October 1971, and the author is indebted to the University, and particularly the Zoology Department, for permission to publish the results.

MATERIALS AND METHODS

489 specimens, including the types of the following species were examined in detail: *Cruriraja parcomaculata*, *C. triangularis*, *Raja doutrei*, *R. pullopunctata*, *R. stenorhynchus*, *R. lanceorostrata*, *R. springeri*, *R. alba*, *R. spinacidermis*, *R. miraletus*, *R. clavata*, *R. straeleni*, *R. robertsi*, *R. radiata*, *R. wallacei*, *R. caudaspinosa*, *R. ravidula*, *R. leopardus*, *R. confundens*, *R. dissimilis*, *Bathyraja smithii*. All material in the collections of the J. L. B. Smith Institute of Ichthyology, Grahamstown, and the Oceanographic Research Institute, Durban, has been re-examined.

Material collected in the South Atlantic by the *Discovery*, FFS *Walther Herwig* and the Belgian South Atlantic Expedition was seen during visits to London, Hamburg and Brussels, while specimens from the eastern North Atlantic, housed in the British Museum (Natural History), Institut für Seefischerei, Institut Royal des Sciences Naturelles de Belgique, and Muséum National d'Histoire Naturelle were examined, including specimens from Sierra Leone and Senegal.

Specimens of *Cruriraja rugosa* and *Anacanthobatis americanus* were obtained from the National Museum of Natural History, Washington, for comparative anatomical studies, and this institution also supplied X-ray photographs of *Raja garmani*, *R. oregoni*, *Pseudoraja fisheri*, *P. atlantica* and *Gurgesiella furvescens*. Further X-ray photographs of *Raja flavirostris*, *Psammobatis extenta*, *P. microps*, *P. lima* and *P. scobina* were supplied by the British Museum (Natural History), of *Raja straeleni* by the Institut für Seefischerei and of *Raja miraletus* and *R. straeleni* by the Institut Royal des Sciences Naturelles de Belgique.

The pelvic girdles of southern African Rajoidea have been examined by means of X-ray photography and the drawings made from the negatives have

been scaled to the same width for comparative purposes. X-ray photographs of the pelvic girdle of *Springeria ori* did not prove to be completely satisfactory, but it appears that this is not unlike the girdle of *Anacanthobatis marmoratus*.

Claspers from adult males of the following species have been examined in detail by dissection: *Cruriraja parcomaculata*, *C. triangularis*, *C. rugosa*, *Raja doutrei*, *R. pullopunctata*, *R. lanceorostrata*, *R. alba*, *R. caudaspinosa*, *R. miraleetus*, *R. clavata*, *R. straeleni*, *R. dissimilis*, *R. confundens*, *R. leopardus*, *R. wallacei*, *Bathyraja smithii*, *Anacanthobatis marmoratus*, *A. americanus*, *Rhinobatos annulatus*, *Myliobatis cervus*. All material had been preserved in either 70% ethyl alcohol or 5% formalin. Where possible several dissections were made for the particular species. Brief examinations of the external morphology of the claspers of other South African Batoidei have been made for comparative purposes: the species include *Rhinobatos ocellatus*, *Gymnura javanica*, *Mobula diabolus*, *Dasyatis thetidis*, *Urotrygon daviesi*, *Heteronarce garmani* and *Torpedo nobiliana*.

Claspers of European *Raja clavata*, *R. radiata*, *R. miraleetus* and *R. batis* and the South American species *R. flavirostris* have also been dissected for comparative purposes.

Vertebral counts were facilitated by the use of X-ray photography. The number of predorsal caudal vertebrae (V_{prd}) has been taken as the number of caudal vertebrae up to the origin of the first dorsal fin (Ishiyama 1952; Krefft 1968a); the number of trunk vertebrae (V_{tr}) and total count ($V\Sigma$) are given according to Krefft (1968a). V_{prd} counts were not possible in *Anacanthobatis marmoratus*, *A. americanus* and *Springeria ori*, as these species lack dorsal fins.

Although Bigelow & Schroeder (1953) have employed X-ray photography in examination of the snout, this method has not been used in this study, because of the small extent of calcification of the rostral cartilages and appendices (Ishiyama & Hubbs 1968). In all cases, the rostral cartilages and rostral appendices were examined by dissection, preserved material being soaked in a weak (2%) solution of NaOH, according to the method of Stehmann (1970). Where possible, the neurocrania were also examined in this way, but in several cases, *Cruriraja triangularis*, *Raja lanceorostrata*, *R. springeri*, *R. stenorhynchus*, *R. straeleni*, *R. robertsi*, *R. dissimilis*, *R. ravidula*, *R. wallacei* and *R. spinacidermis*, dissection of neurocrania could not be made. These were examined by X-ray photography. The neurocrania of *Anacanthobatis marmoratus* and *Springeria ori* could not be examined by dissection, while X-ray photography gave poor results. The cranial characters of these species are therefore not included in the study. Nerve foramina were affirmed by dissection.

PELVIC GIRDLE AND CLASPER STRUCTURE

PELVIC GIRDLE

The pelvic bar is made up of a pair of anlage, which arise together with the basals and peripheral radials in a continuous procartilaginous rudiment (Balfour 1881). While the anlage remain separate in the Holocephali, they fuse

to form a single element, situated in front of the cloaca in Elasmobranchii. Subdivision of the anlage in *Cladodus* suggests that the pelvics arose from a fusion of originally independent basal fin elements.

Contrary to Wiedersheim's theory (1892), Braus (1902) has shown that the pelvic girdle consists of a transverse, bow-like cartilage, from which plate-like girdles, e.g. *Chlamydoselachus* (Daniel 1934: fig. 85), may be derived. The transverse band of cartilage is divisible into a median ischiopubic region and lateral iliac regions, which may be slightly expanded and which are penetrated by obturatorial nerve foramina for the passage of the diazonal nerves. The number of foramina may vary considerably, from one in *Squalus acanthias* to eight in *Chlamydoselachus* (Kälin 1939).

Transverse pelvic bars occur in all batoid families, except the Dasyatidae, Myliobatidae and Mobulidae (Garman 1913: figs 53, 54), in which they are anteriorly arched and bear a single, median, prepelvic process—*processus*

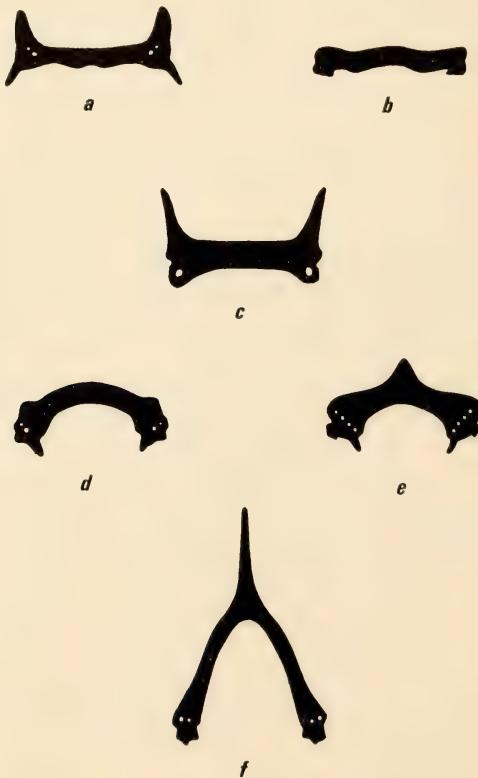


Fig. 1. Pelvic girdles of Batoidei. a. *Rhinobatos* (after Daniel 1934); b. *Platyrhina* (after Garman 1913); c. *Arhynchobatis* (after Garrick 1954); d. *Dasyatis* (after Garman 1913); e. *Myliobatis* (after Garman 1913); f. *Mobula* (after Garman 1913).

praepubicus. However, in the Rhinobatidae, Platyrrhinidae, Rajidae, Anacanthobatidae and Arhynchobatidae, a pair of lateral prepelvic processes arise from the antero-lateral edge of the pelvic bar and are directed anteriorly.

Besides the brief references to the pelvic girdle by Garman (1913) and Garrick (1954, 1957), no comparative investigation of the girdle in Rajoidea has been made.

Typically, the girdle is short and bar-like and is expanded laterally at the iliac regions. Arising from the antero-lateral edges of the iliac regions are a pair of prepelvic processes. In the Anacanthobatidae, the iliac regions are more developed, which together with an increase in length of the prepelvic processes, gives the girdle a U-shape. The girdle appears to be of intermediate shape in *Cruriraja* species and in *Arhynchobatis asperrimus* (Garrick 1954: fig. 3), so that the trend in this mode of development is shown by the series *Raja*, *Cruriraja*, *Arhynchobatis* and *Anacanthobatis* (Fig. 2).

The lengths of the prepelvic processes vary considerably; in *Raja* species, their lengths vary from 0.1 to 0.3 of the girdle width; in *Bathyraja smithii*

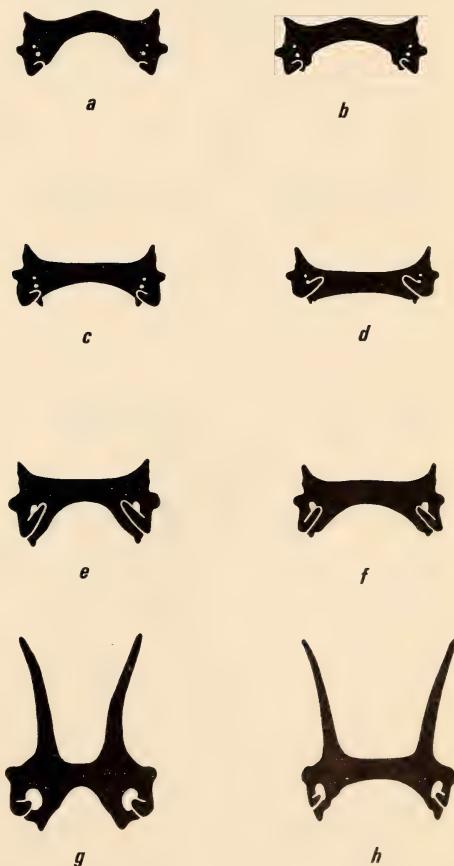


Fig. 2. Pelvic girdles of southern African Rajidae, showing sexual dimorphism.
a. *Raja springeri* (male); b. *R. springeri* (female); c. *Raja confundens* (male); d. *R. confundens* (female); e. *Cruriraja parcomaculata* (male); f. *C. parcomaculata* (female); g. *Anacanthobatis marmoratus* (male); h. *A. marmoratus* (female).

about 0,3; in *Cruriraja* species from 0,1 to 0,2; in *Arhynchobatis asperrimus* about 0,3; and in *Anacanthobatis* species from 0,8 to 0,9.

A short, stout, iliac process arises postero-laterally on each side from the dorsal surface of the bar, but this recurses inwards to point anteriorly and terminates in a bluntly rounded point. The iliac region is usually penetrated by two (sometimes more) obturatorial foramina in most species, but in *Cruriraja parcomaculata*, *C. triangularis* and *Anacanthobatis marmoratus* and in the North Atlantic species *Cruriraja rugosa* and *Anacanthobatis americanus*, there is a single foramen on each side (Fig. 4). Garrick (1954: fig. 3) has shown a single foramen in the monotypic *Arhynchobatis asperrimus*.

Sexual dimorphism is evident in the pelvic girdles (Fig. 2), and although it is not particularly marked in *Raja* and *Bathyraja* species, it is noticeable in *Cruriraja*, *Anacanthobatis* and *Springeria*. In these genera, the posterior edge of the ischiopubic region is strongly arched in males, due partly to the increase in size of the iliac regions, while in females the posterior edge is only slightly arched, giving rise to a much more elongate bar between the prepelvic processes. This feature is probably linked with the oviparous behaviour of the suborder.

The 'black-bellied' skates, *Raja doutrei*, *R. stenorhynchus*, *R. springeri*, *R. pullopectata* and *R. lanceostrata* (Figs 3 a-e) are unusual in that they show a graded variation in anterior arching of the bar, which is unlike the simple, transverse bar of most other species of *Raja*. This type of arched bar, as has been pointed out above, approximates the condition in the Dasyatidae, Myliobatidae and Mobulidae (Fig. 1). However, in these families there is a single, median, prepelvic process, while in black-bellied skates the paired, lateral processes indicative of the rajid condition, are present.

In the *clavata*-group (Figs 3 g, i, j), which in the eastern South Atlantic consists of the species *Raja clavata*, *R. straeleni* and *R. miraletus*, the prepelvic processes show an increase in length from *Raja straeleni* to *R. clavata*. In the latter species the length of the prepelvic processes approximates to that of *Arhynchobatis asperrimus*. Furthermore, slight anterior arching of the ischiopubic bar is seen in *Raja miraletus* and *R. clavata*.

The girdle of *Bathyraja smithii* (Fig. 3 t) resembles that of *Raja clavata* and *R. miraletus* in the length of the prepelvic processes, but differs in the iliac processes. These are only slightly curved in *Bathyraja smithii*, and so attain a position intermediate between that of *Rhinobatos* (Fig. 1 a) and most typical rajids. It should be noted that a similar condition of the iliac processes is found in *Raja robertsi* (Fig. 3 s), but in this species the prepelvic processes are much shorter than in *Bathyraja smithii*, and the girdle represents a case intermediate between that of *Raja radiata* (Fig. 3 r) and *Bathyraja smithii*.

A straight, transverse bar is found in the species *Raja dissimilis*, *R. ravidula*, *R. confundens*, *R. wallacei*, *R. leopardus*, *R. caudaspinosa* and *R. spinacidermis* (Figs 3 k-q), in which cases there is some variation in the prepelvic length. However, in *Raja wallacei* and *R. caudaspinosa* (Figs 3 n, p), the iliac processes appear to be more strongly developed than in the other species, except *Raja*

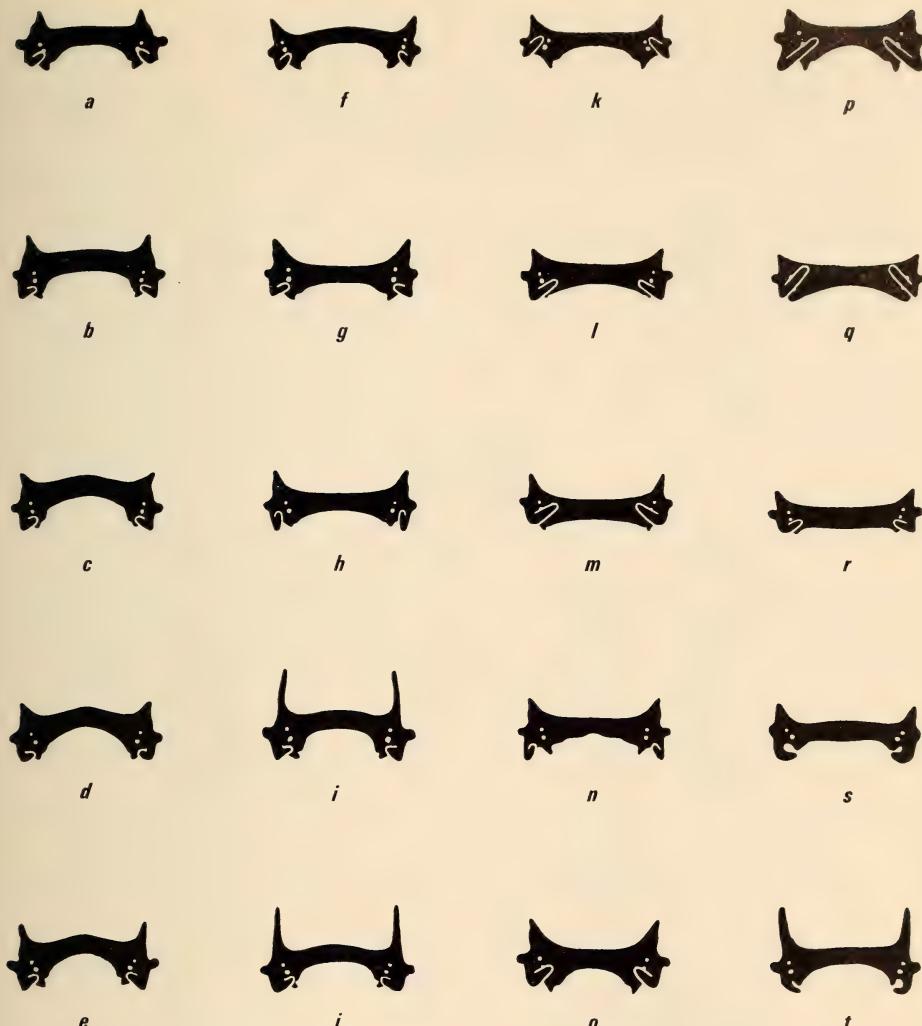


Fig. 3. Pelvic girdles of southern African Rajidae. a. *Raja doutei*; b. *R. stenorhynchus*; c. *R. springeri*; d. *R. pullo punctata*; e. *R. lanceostrata*; f. *R. flavirostris* (South American); g. *R. straeleni*; h. *R. alba*; i. *R. miraleetus*; j. *R. clavata*; k. *R. dissimilis*; l. *R. ravidula*; m. *R. confundens*; n. *R. wallacei*; o. *R. leopardus*; p. *R. caudaspinosa*; q. *R. spinacidermis*; r. *R. radiata*; s. *R. robertsi*; t. *Bathyraja smithii*.

spinacidermis (Fig. 3 q), which represents the extreme case. In this species the iliac processes extend forward to the anterior edge of the pelvic bar, and in one specimen (the type) the processes extend beyond the edge.

A similar condition is seen in *Cruriraja* species (Figs 4 a-c), where the length of the prepelvic processes approximates that of typical rajids, but where the iliac processes are more massively developed. However, in *Cruriraja parcomaculata*, *C. triangularis* and *C. rugosa*, the iliac processes do not reach the anterior

edge of the bar, as they do in *Raja spinacidermis*.

In *Anacanthobatis marmoratus* (Fig. 4 d), *A. americanus* and *Springeria ori*, it is the prepelvic processes which are strongly developed, being almost equal in length to the width of the girdle. On the other hand, the iliac processes are reduced to small, truncate protuberances.

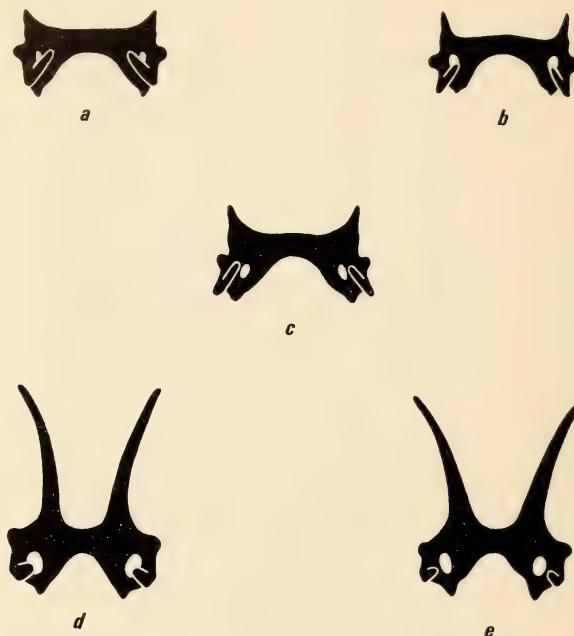


Fig. 4. Pelvic girdles of southern African Rajoidea. a. *Cruriraja parcomaculata*; b. *C. triangularis*; c. *C. rugosa* (North Atlantic); d. *Anacanthobatis marmoratus*; e. *A. americanus* (North Atlantic).

CLASPER STRUCTURE

Although there are major differences in the siphon and clasper gland structure between Selachii and Batoidei (Leigh-Sharpe 1926; White 1937), it is the distal end of the clasper which is important in the systematics of lower taxa. Anatomical investigations on the clasps of European rajids have been made by Petri (1878), Jungersten (1899), Huber (1901), Leigh-Sharpe (1920-6) and Stehmann (1970), while Ishiyama (1958) and Ishiyama & Hubbs (1968) have made detailed studies of the structure and systematic significance of the organ in Japanese rajids. Hulley (1966, 1969) has described the clasper structure of several South African species, and although he has figured the external structure of the claspers in eastern South Atlantic species (1970), detailed comparative anatomical studies of these organs have not been made.

Terminology of external features

Leigh-Sharpe (1920-6) defined most of the terminology used in clasper anatomy, but it can be seen that his use of a particular term is not always constant, since the same cartilaginous element is not always involved. The reason for this is that he dealt only with the external morphology of the organ, without reference to the internal cartilages.

Furthermore, differences in terminology of clasper components as employed by Leigh-Sharpe (1920-6), and by Ishiyama (1958) and Ishiyama & Hubbs (1968), have added to the confusion. In order to standardize, Stehmann (1969) evaluated the terms pseudosiphon, slit, rhipidion and spur, and gave precise definitions for his nomenclature. While the terminology used here is mainly in accordance with his findings, there appears to be confusion in several other structures. A discussion of all problematic components, applicable to southern African Rajidae, follows below:

(1) *pseudosiphon*

Leigh-Sharpe (1921: 361) introduced the term pseudosiphon for *Galeus vulgaris*, defining it as 'a small blindly ending sac, whose wide aperture points in a posterior direction'. He shows that the pseudosiphon is situated on the outer surface of the dorsal lobe of the clasper glans (1921: fig. 2). However, in *Raja* species (*R. clavata*, *R. blanda*, *R. marginata*), he indicates that the pseudosiphon lies on the inner surface of the dorsal lobe. Ishiyama (1958) gives a

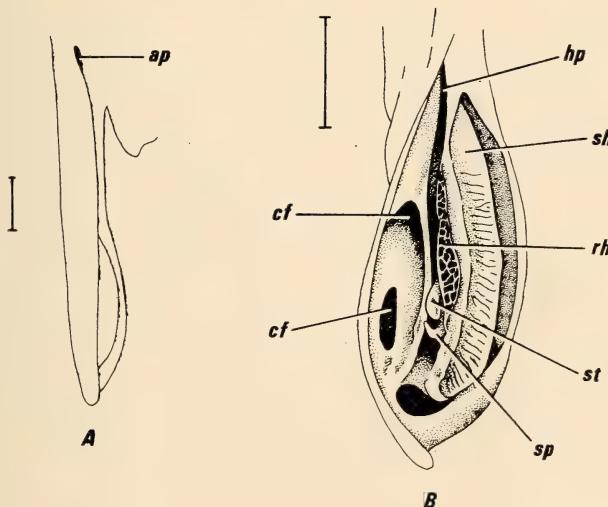


Fig. 5. *Raja lanceorostrata*. A. external view of right clasper from dorsal side; B. lateral view of right clasper opened to show structural features of the glans. Scale 2.0 cm.
cf—cleft; hp—hypopyle; rh—rhipidion; sh—shield; sp—spike; st—sentinel.

similar definition and points out that the pseudosiphon is always related to modifications of the dorsal terminal cartilages.

In 1968, Ishiyama & Hubbs defined the pseudosiphon more precisely, relating it to the degree of development of a single cartilage, the dorsal terminal 1. They point out that a pseudosiphon is indicative of the genus *Bathyraja*.

According to Stehmann (1969), Ishiyama's first definition of the pseudosiphon could be interpreted to mean that the structure could be found either on the outer surface or the inner surface of the dorsal lobe. However, Ishiyama (1958: fig. 3) has shown that the pseudosiphon is situated externally. Further, in his discussion of the slit, he points out that this structure may be related to dorsal terminal cartilages, but (1958: 202) 'has no close relation to the dorsal terminal 1', inferring that the pseudosiphon does have a relationship with that cartilage. Therefore, it appears that there is no distinction between the Ishiyama (1958) definition and the Ishiyama & Hubbs (1968) definition.

In all species investigated in this paper, except those of the genus *Cruriraja*, the dorsal terminal 1 cartilage overlies the other dorsal terminals, so that if a pseudosiphon is related directly to the dorsal terminal 1, then it must be situated externally, on the outer surface of the dorsal lobe of the glans. It would appear, therefore, that the structure referred to as a pseudosiphon by Leigh-Sharpe (1920-6) in the species *Raja clavata*, *R. blanda* and *R. marginata*, which occurs on the inner surface of the dorsal lobe, should be given a new name. In

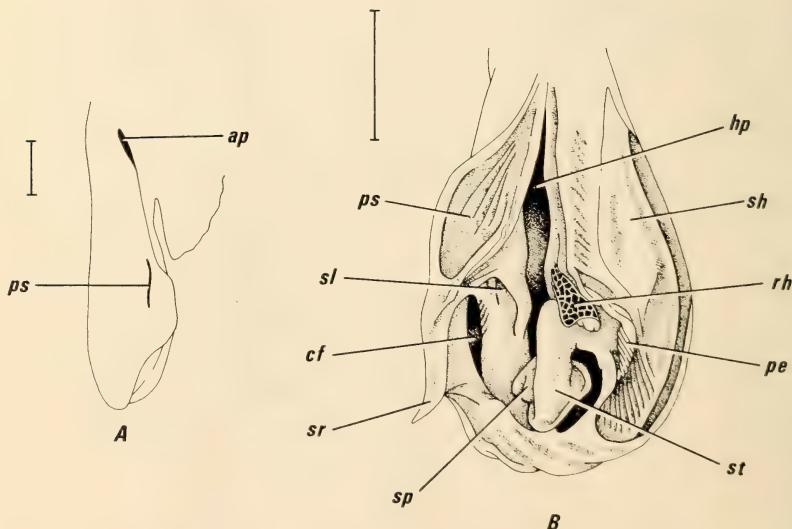


Fig. 6. *Raja radiata* (North Atlantic). A. external view of right clasper from dorsal side; B. lateral view of right clasper opened to show structural features of the glans. Scale 2,0 cm.

ap—apopyle; cf—cleft; hp—hypopyle; pe—pent; rh—rhipidion; ps—pseudosiphon; sl—slit; sh—shield; sp—spike; sr—spur; st—sentinel.

Raja clavata, *R. blanda* and others, Stehmann (1969, 1970) has referred to this structure as the 'inner pseudosiphon', but because it houses the sentinel in these species, Hulley (1970) has proposed the term pocket. This has been followed by Stehmann (1971a, b), who recognizes a pocket, rather than an inner pseudosiphon, in *Raja herwigi* and *R. maderensis*. However, it should be noted that the pseudosiphon which Leigh-Sharpe (1924) described in *Raja marginata* is entirely different to the pocket, and has been referred to the term cleft.

Stehmann (1969) expresses some concern as to the question of priority in terminology. However, an accurate definition for the pseudosiphon was never given, since Leigh-Sharpe (1920-6) made numerous misidentifications of this structure, presumably discriminating it by its position in the clasper alone. Ishiyama's definition can therefore be used (see p. 19).

It should be noted that Stehmann (1970) has distinguished a pseudosiphon in the species *Raja fyllae*. I have found that in this species, as in *Raja wallacei* (Fig. 7 A) and *R. caudaspinosa*, the cavity on the outer dorsal wall is formed by an indentation in the musculature which is attached to the dorsal terminal 1 (*m. dilatator*), and further that this cavity is not found in all specimens. I have therefore not described this as a real and separate structure, comparable to the pseudosiphon. Stehmann (personal communication) feels that this must be left to the discretion of the author.

In *Cruriraja* species, the dorsal terminal 1 is differently situated (Figs 40, 41, 42), so that it does not overlie the other dorsal terminal cartilages to any great

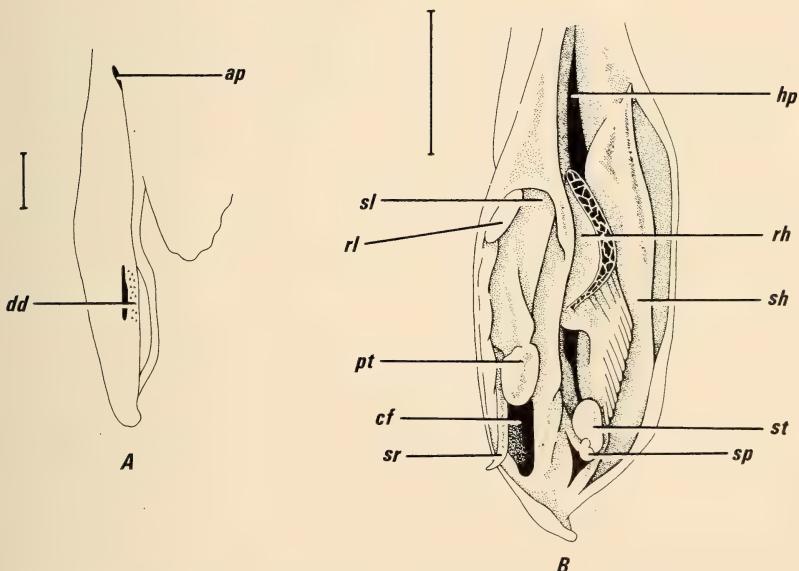


Fig. 7. *Raja wallacei*. A. external view of right clasper from dorsal side; B. lateral view of right clasper opened to show structural features of the glans. Scale 2.0 cm.
 ap—apopyle; cf—cleft; dd—dermal denticles; hp—hypopyle; pt—promontory;
 rh—rhipidion; rl—roll; sl—slit; sh—shield; sr—spur; sp—spike; st—sentinel.

extent. However, a small cavity is formed between the distal end of the dorsal terminal 2 and the concavity of the dorsal terminal 1. This cavity is situated on the inner surface of the dorsal lobe of the glans. Because of its close association with the dorsal terminal 1 cartilage, I have termed this structure the pseudosiphon, but it is obviously formed in a different manner and lies transversally to, rather than in the longitudinal axis of, the clasper. It may therefore necessitate the introduction of a new term.

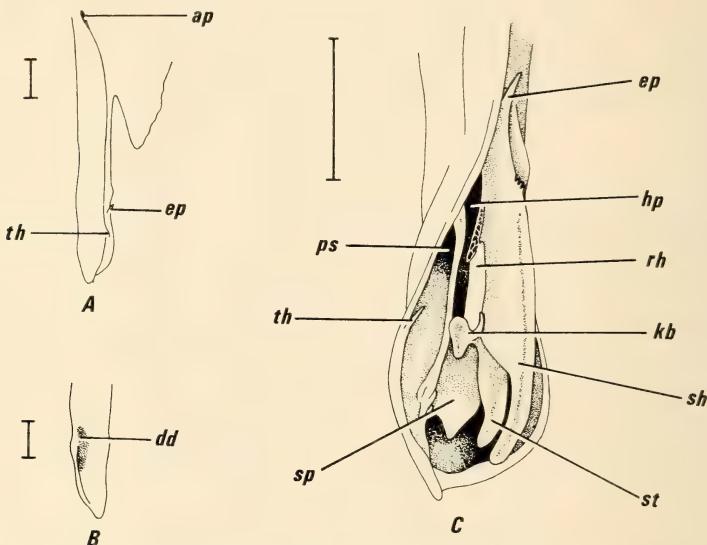


Fig. 8. *Cruriraja triangularis*. A. external view of right clasper from dorsal side. B. ventral surface of right clasper; C. lateral view of right clasper opened to show structural features of the glans. Scale 1,0 cm.

ap—apopyle; dd—dermal denticles; ep—eperon; hp—hypopyle; kb—knob; ps—pseudosiphon; rh—rhipidion; sh—shield; sp—spike; st—sentinel; th—thorn.

In some Batoidei (Figs 12 A-H), there is a cavity situated on the outer surface of the ventral lobe of the glans, which I have termed the ventral pseudosiphon, again because of its close association with the dorsal terminal 1 cartilage. This corresponds to the lateral pocket of Jungersen (1899). Leigh-Sharpe (1920-6) has termed this the slit (see below), sentina and crumena in *Torpedo marmorata*, *Rhinobatos productus* and *Cestracion philippi* respectively, but in others, *Trygon pastinacea* and *Myliobatis aquila*, has left it unlabelled. Similarly, Ishiyama (1958) does not label this structure in *Rhinobatos schlegeli* and *Platyrhina sinensis*.

(2) slit

Leigh-Sharpe (1920-6) does not clearly define the term slit, mentioning it only as a cavity, which may be internal, e.g. *Raja batis*, *R. linnea*, or may be situated on the outer surface of the dorsal lobe, e.g. *Raja murrayi*, *R. eatoni*. From its position in the latter species, and from the fact that *Raja eatoni* is

considered to be synonymous with *Bathyraja smithii* (Hulley 1970), it may be concluded that these cavities correspond to pseudosiphons, according to the above proposed definition.

Ishiyama (1958: 202) defines the slit as a 'small, shallow cavity formed by fleshy skin on the inner surface of the dorsal lobe and has no relation to dorsal terminal i'.

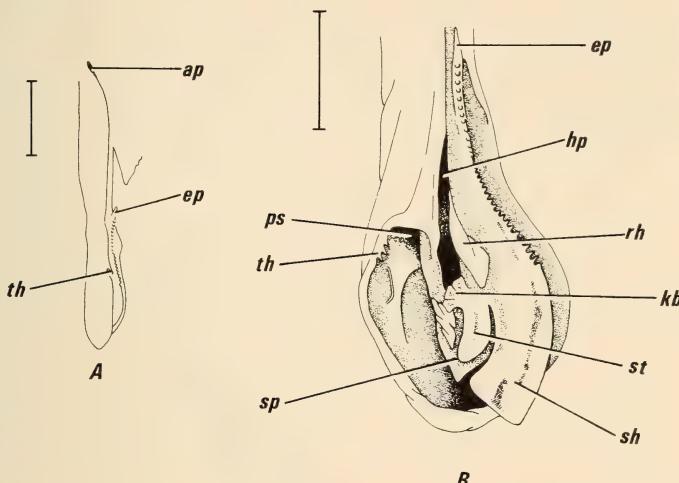


Fig. 9. *Cruriraja rugosa*. A. external view of right clasper from dorsal side. B. lateral view of right clasper opened to show structural features of the glans. Scale 2.0 cm.
ap—apopyle; ep—eperon; hp—hypopyle; kb—knob; ps—pseudosiphon; rh—rhipidion; sh—shield; sp—spike; st—sentinel; th—thorn.

Stehmann (1969) points out that Ishiyama has not used the term consistently, especially where there are two or more cavities on the inner surface of the dorsal lobe. He recognizes that two structures (not including the pseudosiphon) may be involved: (1) a skinny flap, situated proximally in the glans, which has no relation to any dorsal terminal cartilage, and is so orientated that the sac lies at right angles to the longitudinal axis of the clasper; and (2) a cavity which may be formed between any dorsal terminal cartilage (other than the dorsal terminal i) and the axial or dorsal marginal cartilage, i.e. it is a cavity which is bounded by cartilaginous elements. The first cavity is regarded as the slit, the second has been termed the cleft. I agree with this distinction, and have subsequently used Stehmann's definitions for these dorsal cavities.

It should be noted that the cavity formed in the ventral lobe of the clasper in Dasyatidae and Mabulidae, and which has been referred to as a slit by Leigh-Sharpe (1920: fig. 15; 1926: figs 12, 14, 15), is now referred to as a ventral pseudosiphon. The slit is therefore always situated on the inner surface of the dorsal lobe of the glans.

(3) *rhipidion: pseudorhipidion*

Definitions for both these structures have been given by Ishiyama (1958), who relates the smooth-surfaced, dorsally situated pseudorhipidion to the distal end of the dorsal marginal cartilage, while pointing out that the pitted, ventrally situated rhipidion is composed entirely of erectile tissue and has no relation to cartilaginous elements. Stehmann (1969), however, points out that Ishiyama is incorrect in his restriction of the term rhipidion to *Raja* species (1958) or *Raja* and *Breviraja* species (Ishiyama & Hubbs 1968), and pseudorhipidion to *Bathyraja*, since members of his *clavata*-group (subgenus *Raja*: Stehmann (1970)) possess a pseudorhipidion. The presence of a pseudorhipidion is therefore not a suitable character for the separation of the genus *Bathyraja* from other rajids.

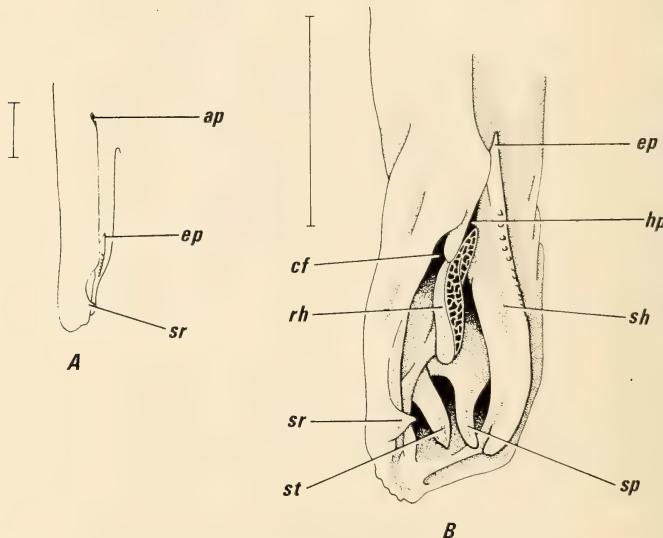


Fig. 10. *Anacanthobatis marmoratus*. A. external view of right clasper from dorsal side; B. lateral view of right clasper opened to show structural features of the glans. Scale 1,0 cm.

ap—apopyle; cf—cleft; ep—eperon; hp—hypopyle; rh—rhipidion; sh—shield; sp—spike; sr—spur; st—sentinel.

(4) *spur*

Leigh-Sharpe (1920-6) described this structure in *Raja radiata*, referring to it as a hard, cartilaginous point, which curves outward from the dorsal lobe of the glans (Fig. 6 B, sr). Stehmann (1969, 1970) has shown that this structure is directly related to the dorsal terminal 3 cartilage. On the other hand, Ishiyama (1958) refers the spur to a structure on the inner surface of the ventral lobe, which is formed by the accessory terminal, while Ishiyama & Hubbs (1968: figs 2 A, B) refer the spur to the ventral terminal cartilage. It is felt that Leigh-Sharpe and Stehmann should be followed, and that Ishiyama should redefine his structures.

(5) *funnel*

The term was introduced by Ishiyama (1958: 203) as 'a component located on the distal portion of the ventral lobe, having a soft projection like the foot of a bivalve mussel'. He relates this structure directly to the ventral terminal cartilage.

It can be seen that in those species in which the funnel is present (Ishiyama 1958: fig. 4) it always overlies the 'spur', where this is present, on the inner ventral surface. Examination of the corresponding cartilages (Ishiyama 1958: fig. 12) reveals that in these species the only cartilage which can possibly overlie the accessory terminal ('spur') is the distal end of the ventral marginal. Furthermore, Ishiyama (1958) introduces the term claw for the species *Rhinoraja odai* and *Rhinoraja longicauda*, relating this to a modification of the accessory terminal cartilage. However, he shows (1958: fig. 11) that the accessory terminal in these species is a single cartilage, which is flat and sharp-edged and quite unlike the external claw. Again, examination of the figures (Ishiyama 1958: fig. 12) shows that the cartilage which overlies the accessory terminal (knife), and is extended distally, is the ventral marginal cartilage.

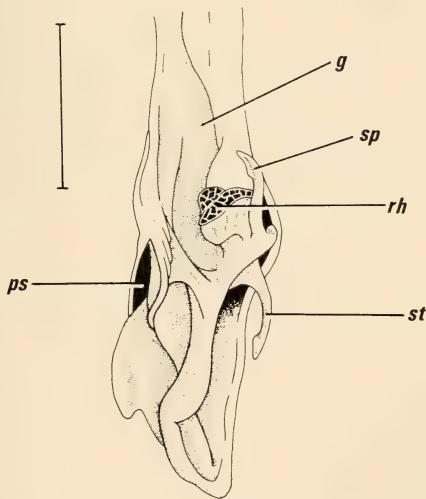


Fig. 11. *Anacanthobatis americanus*. Lateral view of right clasper opened to show structural features of the glans. Scale 1,0 cm.

g—clasper groove; ps—pseudosiphon; rh—rhipidion; sp—spike; st—sentinel.

This means therefore that neither the ventral terminal nor the accessory terminal can be related to the term funnel or claw, and that clearly the ventral marginal is the associated cartilage in both cases. Further confusion is added because the claw in *Rhinobatos schlegeli* and *Rhinobatos annulatus* (Ishiyama 1958: figs 13, 14) is formed by the accessory terminal cartilage.

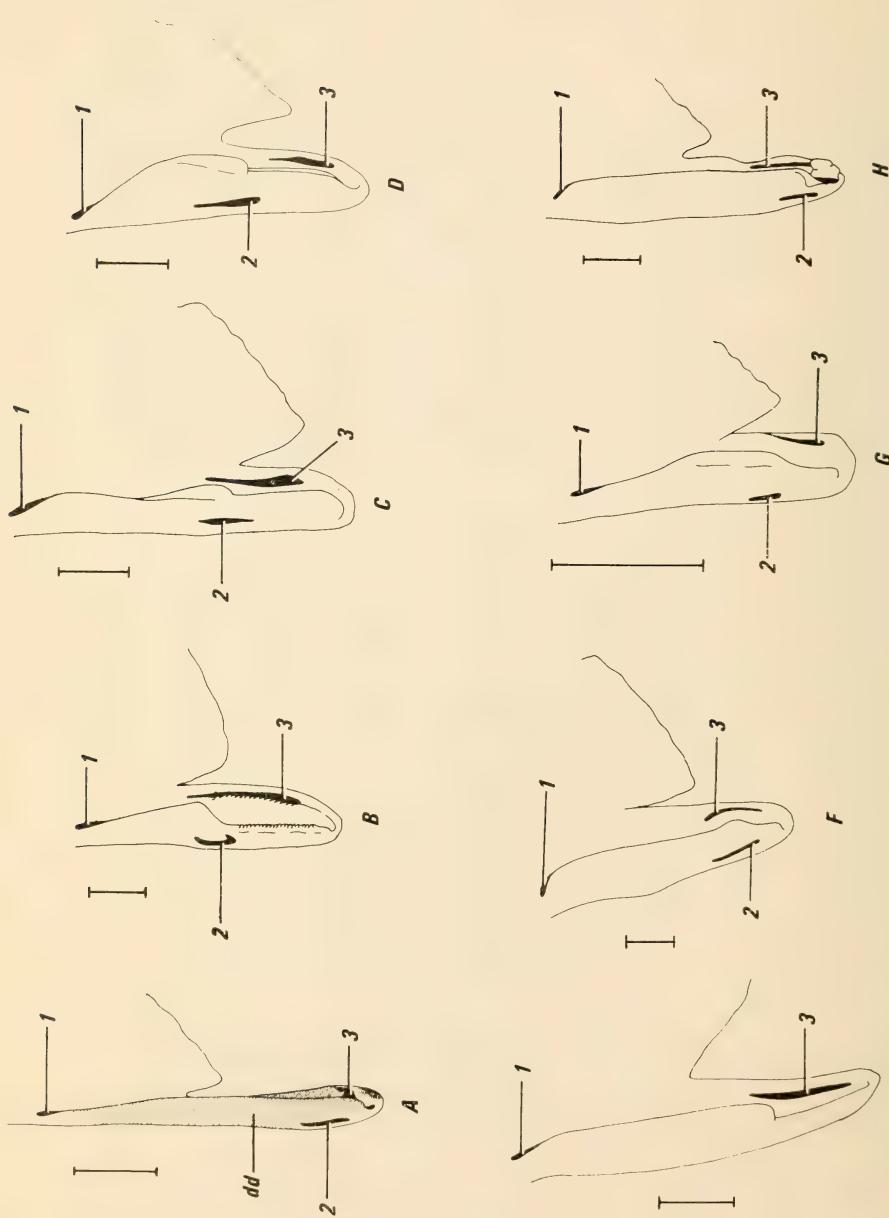


Fig. 12. External view of right clasper of southern African Batoidei (excluding Rajoidea) from dorsal side. 1—apopyle; 2—ventral pseudosiphon; 3—dermal denticles. Scale 2,0 cm. A. *Rhinobatos ocellatus*; B. *Gymnura natalensis*; C. *Rhinobatida javanica*; D. *Mobula diabolus*; E. *Dasyatis daviesi*; F. *Urotrygon thetidis*; G. *Heteronarcine garmani* (scale 1,0 cm); H. *Torped nobiliana*.

Stehmann (1969) correctly follows Ishiyama's definition, relating the term funnel to the ventral terminal cartilage, while introducing Leigh-Sharpe's term, projection, for the distally situated, elongate, cartilaginous structure formed by the ventral marginal cartilage. Hence the term projection of Stehmann (1969, 1970) is equivalent to the terms funnel/claw of Ishiyama, while the term funnel of Stehmann is clearly a different structure.

It should be noted that although Leigh-Sharpe (1926) did not include the term projection in his list of clasper components, and does not adequately define this structure, he shows that in *Raja lincea* (1924: fig. 6) the projection is an expansion on the inner lateral edge of the shield. This can therefore be related directly to the ventral terminal cartilage, and as such, is a different structure to the projection of Stehmann.

It is suggested that the term funnel be applied to the distal protrusion of the ventral terminal cartilage, as in *Raja clavata* (Fig. 22), while the structure which is related to the distal protrusion of the ventral marginal be known as the projection. The adoption of this convention would avoid further confusion, especially with regard to Stehmann's definitions.

The structure which is regarded as the projection by Leigh-Sharpe must therefore be referred to some other term, if in fact it is an identifiable and real clasper component.

Furthermore, the projection as now defined would cover the terms spike in *Raja murrayi* and the sentinel in *Raja eatoni* (Leigh-Sharpe 1924: figs 13, 14). The term claw should be retained and reserved solely for the structure formed by the accessory terminal cartilage in *Rhinobatos*, *Platyrhina* and *Myliobatis*.

(6) *pecten*

The structure was recognized as a component in *Raja marginata* (= *Raja alba*) and was defined (Leigh-Sharpe 1924) as a long, hard structure, bearing six or more hard projections or serrations, which is situated on the outer lateral margin of the dorsal lobe of the clasper.

Dissection of the clasper of *Raja alba* (Fig. 33) has revealed that the pecten is directly related to the sharp protuberances or serrations, which are developed on the outer lateral margin of the dorsal terminal 3 cartilage. A pecten was also described in the clasper of *Raja miraletus* (Hulley 1969), but in this species the dorsal terminal 2 cartilage is involved. However, since the serrations are developed in a similar position to those in *Raja alba*, and since the orientation and probably the function is identical, I have termed both structures the pecten. This has been followed by Stehmann (1971a), who distinguishes a pecten, formed by the dorsal terminal 2 cartilage, in *Raja herwigi*.

(7) *scale and dermal denticles*

Ishiyama (1958) pointed out that in two Japanese subspecies, *Bathyraja smirnovi smirnovi* and *B. smirnovi ankasubae*, minute scales were present on the outer border of the ridge. As such a phenomenon had not been reported for

European rajids, he recognized them as a separate clasper component, which he defined as the scale.

Dermal denticles are present on the outer surface of the dorsal lobe of the clasps of *Raja confundens*, *R. leopardus* and *R. wallacei* (Hulley 1970: figs 17–19). Although the lateral area would correspond with the ridge, if this had been developed, I have preferred to regard such denticles as a separate component to Ishiyama's scale.

This means, therefore, that scale is a term which is restricted to dermal denticles on the ridge, and is probably only applicable in the genus *Bathyraja*, in which the ridge is developed. Dermal denticles are found in other rajid genera. However, both these components have a similar derivation and as such could possibly be referred to the same term.

(8) terminal bridge

Ishiyama (1958) first described the terminal bridge as a short, bar-like cartilage, which connects the axial cartilage with the distal end of the dorsal terminal 2 cartilage. He derived the terminal bridge from an offshoot of the accessory terminal 2. However, he does not recognize this as a separate clasper component (1958: tables 3, 4). Hulley (1966, 1969) also recognized the existence of this linking cartilage in *Raja pullospunctata*, where it separates the two dorsal clefts, and in *Raja miraletus*, where it separates the cleft from the pocket. In both species, the terminal bridge links the axial with the dorsal terminal 2 cartilage.

Stehmann (1969, 1970, 1971a, b) regards the terminal bridge as a real component, identifiable in the external anatomy of the clasps of *Raja brachyura*, *R. montagui*, *R. herwigi*, *R. maderensis* and *R. straeleni*, and directly related to the development of one or two small, cartilaginous rods. In these species, the rods link the axial with the dorsal terminal 2 cartilage and separate the cleft from the pocket.

I have found this linking cartilage in *Raja doutrei*, where it joins the axial to the dorsal terminal 2 (Fig. 30), thereby separating the two clefts in the dorsal lobe. It is absent in *Raja lanceorostrata* (Fig. 31), where the dorsal terminal 2 itself makes contact with the axial. This is the case with *Raja radiata*, *R. dissimilis*, *R. caudaspinosa*, *R. confundens* and *R. leopardus*, but in *R. wallacei* the connection is formed between the axial and the dorsal terminal 3 cartilage.

Furthermore, a cartilaginous connection is present in *Cruriraja parcomaculata*, *C. triangularis* and *C. rugosa* (Figs 40–42), but in these species the connection is completely different from the above. It is made between the accessory terminal 2 and the axial. It would appear, therefore, that the terminal bridge is not constant in orientation and it is suggested that this element helps bind the cartilages of the terminal group to the axial, thereby acting antagonistically to the contraction of the *m. dilatator*.

Because of this, and because of the different areas of insertion (dorsal terminal 2, accessory terminal 2), it is felt that the terminal bridge should not

be recognized as a separate and distinct component, even though it might be evident in the external and internal morphology of the glans (cf. Stehmann 1971b).

(9) *pent*

The term was originally used to describe a ventral, ridge-like fold in *Trygon pastinacea* (Leigh-Sharpe 1922: fig. 17). This fold is situated at about the level of the hypopyle and presumably acts in much the same way as the rhipidion. Ishiyama (1958: fig. 4 A) recognizes a pent in *Bathyraja tobitukai*, which is similarly positioned in the glans.

The pent described by Stehmann (1969, 1970) is an elongate ridge, which is pleated and runs parallel to the midline of the organ, from the distal end of the rhipidion. Although this does not appear to be equivalent to the above, Stehmann's definition has been followed to avoid further confusion.

(10) *sentina*

The sentina originally described by Leigh-Sharpe (1922) was an external cavity in *Rhinobatos productus*. This cavity was subsequently labelled as the slit or crumena in later papers by this author. As has been pointed out above, the external cavity on the ventral surface of the clasper has now been termed the ventral pseudosiphon, because of its association with the dorsal terminal 1 cartilage. The term sentina has been reserved for an internal structure of the glans, and is defined below.

(11) *promontory*

The promontory recognized by Ishiyama & Hubbs (1968: figs 2 C, D) in *Breviraja colesi* is clearly related to the proximal region of the dorsal terminal 3 cartilage. On this basis, the promontory was recognized in *Raja wallacei* (Hulley 1970: fig. 19). However, Leigh-Sharpe (1920-6) and Stehmann (1969, 1970) regard the promontory as the distal projection of the dorsal terminal 2 cartilage, while the structure associated with the dorsal terminal 3 is termed the roll. This interpretation is accepted and to avoid confusion the structures have been reidentified and relabelled in *Raja wallacei* (Fig. 7).

Description

Definitions of the external components of the clasper glans of southern African Rajoidea are given below, and their occurrence is described and figured (Figs 5-14; Hulley 1970: figs 4-21). For definitions of the apopyle and siphon gland, the reader should refer to Leigh-Sharpe (1920-6).

Components of the dorsal lobe

(1) *pseudosiphon* (Ishiyama)

A cavity situated on the outer surface of the dorsal lobe of the glans at about the level of the hypopyle; it has an oval aperture, the long axis of which is orientated in the longitudinal axis of the organ; its degree of development is directly dependent upon the shape and location of the dorsal terminal 1 cartilage.

A pseudosiphon is present in *Bathyraja smithii* (Hulley 1970: fig. 21), *Raja robertsi* (Hulley 1970: fig. 12) and *R. radiata* (Fig. 6) where it is situated on the outer surface of the dorsal lobe. In these species, the outer lateral margin of the pseudosiphon is formed by the dorsal terminal 1 cartilage, so that the cavity can be easily seen and opened by spreading this cartilage. A groove, which is similarly located, is found in some specimens of *Raja caudaspinosa* and *R. wallacei* (Fig. 7), but since this is developed as a fold in the musculature, and is not present in all specimens, it has not been identified as the pseudosiphon (cf. *Raja fyllae*, *R. fullonica*: Stehmann 1969; 1970).

In *Cruriraja* species (Hulley 1970: fig. 4; Figs 8, 9) a pseudosiphon has been distinguished on the inner surface of the dorsal lobe. Unlike the above, this cavity has a transverse aperture, but since it has a relationship with the dorsal terminal 1 cartilage, it has been termed the pseudosiphon.

The outer lateral edge of the dorsal terminal 1 also forms the dorsal lip of the pseudosiphon in *Anacanthobatis americanus* (Fig. 11), which, unlike the South African species *A. marmoratus*, possesses a pseudosiphon on the outer dorsal wall of the glans.

Both *Rhinobatos annulatus* (Fig. 13) and *Myliobatis cervus* (Fig. 14) possess a pseudosiphon in the outer dorsal wall. However, it should be noted that in these species, as in *Rhinobatos schlegeli* and *Platyrhina sinensis* (Ishiyama 1958), the dorsal terminal 1 is situated on the ventral side of the glans.

A brief examination of the following southern African Batoidei has confirmed the presence of a pseudosiphon in *Rhinobatos ocellatus*, *Gymnura*

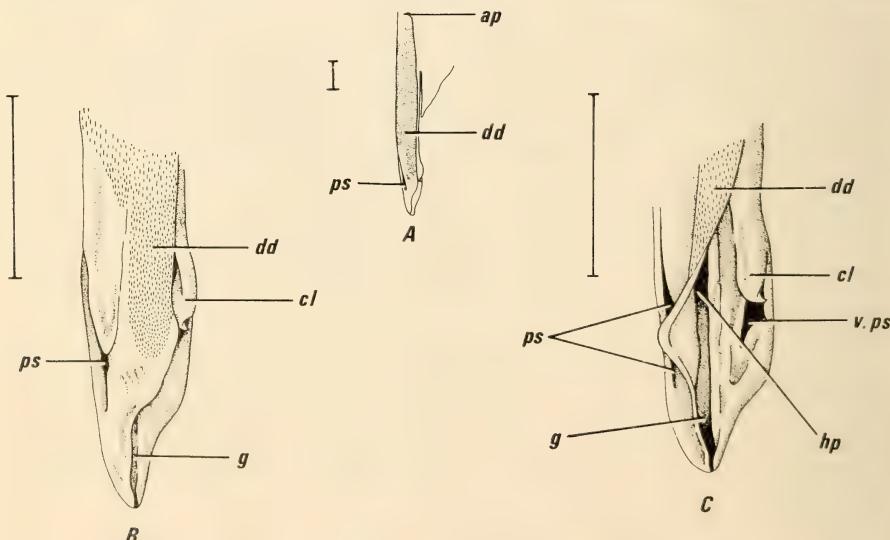


Fig. 13. *Rhinobatos annulatus*. A. external view of right clasper from dorsal side; B. distal tip of right clasper; C. lateral view of right clasper opened to show structural features of the glans. Scale 1,0 cm.

ap—apopyle; cl—claw; dd—dermal denticles; g—clasper groove; hp—hypopyle; ps—pseudosiphon; v.ps—ventral pseudosiphon.

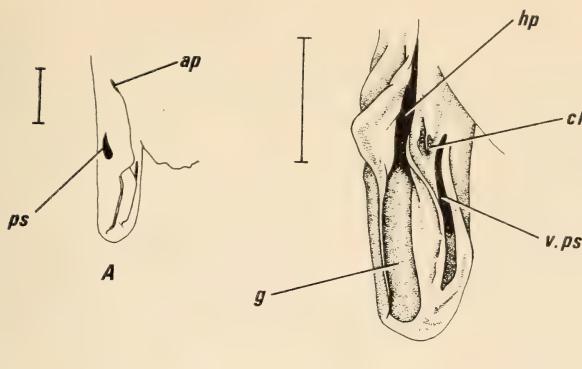


Fig. 14. *Myliobatis cervus*. A. external view of right clasper from dorsal side; B. lateral view of right clasper opened to show structural features of glans. Scale 2.0 cm.

ap—apopyle; cl—claw; g—clasper groove; hp—hypopyle; ps—pseudosiphon; v.ps—ventral pseudosiphon.

natalensis, *Mobula diabolus*, *Rhinoptera javanica*, *Heteronarce garmani* and *Torpedo nobiliana* (Fig. 12). The pseudosiphon in these species is dorsally situated and should not be confused with the cavity on the ventral surface, which has been identified as the ventral pseudosiphon (Fig. 12).

(2) cleft (Stehmann)

A small cavity, situated on the inner surface of the dorsal lobe of the glans, which is formed between the axial or dorsal marginal cartilages and any other dorsal terminal cartilage except the dorsal terminal 1, i.e. a cavity bounded by cartilages other than the dorsal terminal 1 cartilage.

Two clefts are present in *Raja doutrei*, *R. pullo punctata*, *R. lanceostrata*, *R. caudaspinosa* and *R. dissimilis* (Hulley 1970: figs 5, 6, 7, 15; Fig. 5). The proximal cleft in these species is formed as a cavity between the axial cartilage and the dorsal terminal 2. A similar gap between these cartilages is found in *Raja wallacei*, *R. confundens* and *R. leopardus* (Figs 35–37), but a proximal cleft is not present externally. In *Raja confundens* and *R. leopardus* the axial and dorsal terminal 2 are in close proximity, while in *Raja wallacei* the gap is closed by the protrusion of the promontory (dorsal terminal 2). A slit is developed in this region in the species.

The cleft in the species *Raja clavata*, *R. straeleni*, *R. alba* and *R. miraleetus* (Hulley 1970: figs 8–11) is differently formed, in that the cartilages bounding the cavity are the dorsal marginal and the dorsal terminal 2.

A distal cleft occurs in all species except *Raja alba*, *R. clavata*, *R. straeleni* and *R. miraleetus*; in *R. pullo punctata* (Hulley 1966: fig. 5) the distal cleft is formed between the axial cartilage and the dorsal terminal 2; in *R. doutrei* and *R. lanceostrata* (Figs 30, 31) between the axial and dorsal terminal 3; and in *R. radiata*, *R. caudaspinosa*, *R. dissimilis*, *R. wallacei*, *R. confundens* and *R. leopardus* between the axial and dorsal terminal 4 (Figs 34–39). It is interesting to note

that when a distal cleft is present, the proximal border of this cleft is always formed either by the terminal bridge or the dorsal terminal 2 cartilage.

While a proximally situated cleft is present in *Anacanthobatis marmoratus* (Fig. 10), it is absent in *A. americanus*. A cleft is also absent in *Bathyraja smithii* and *Rhinobatos annulatus*.

(3) slit (Leigh-Sharpe)

A small, blindly-ending sac, formed as a skinny flap on the inner dorsal surface of the proximal region of the glans; it is not bordered by cartilaginous elements and is not associated with cartilages. Two or more slits may be developed (Ishiyama 1958; 1967).

This structure is present in *Raja radiata*, *R. leopardus*, *R. wallacei*, *R. confundens* and *Bathyraja smithii* (Figs 6, 7; Hulley 1970: figs 17–19, 21). In these, the gap formed between the axial cartilage and the dorsal terminal 2 appears to be obscured by the development of other cartilages in this area, i.e. in *Raja radiata* by the dorsal marginal (Fig. 34), in *R. wallacei* by the dorsal terminal 2 (Fig. 35) and in *R. confundens* and *R. leopardus* by the close proximity of the dorsal terminal 2 cartilage to the axial (Figs 36, 37).

(4) pocket (new term)

A small, shallow cavity, which is situated distally on the inner dorsal wall of the clasper glans; it is bordered medially by the axial cartilage, while its outer lateral wall consists of connective tissue, which runs between the dorsal terminal 2 and the axial tip. It serves as a covering for the sentinel, in those species in which the sentinel is massively developed.

A pocket is present in *Raja clavata*, *R. straeleni* and *R. miraletus* (Hulley 1970: figs 9–11) and has been recognized in *R. herwigi* and *R. maderensis* (Stehmann 1971a, b).

(5) pseudorhipidion (Ishiyama)

A cartilaginous tongue, situated on the inner lateral margin of the dorsal lobe of the glans, close to the midline and at about the level of the hypopyle; it is formed by the distal projection of the dorsal marginal cartilage into the glans. Its function is to spread the ejaculating spermatozoa (Leigh-Sharpe 1920).

A pseudorhipidion is present in *Raja clavata*, *R. straeleni* and *R. miraletus* (Hulley 1970: figs 9–11), where it runs parallel to the midline of the organ for about one-third the length of the glans. However, in *Raja alba* (Hulley 1970: fig. 8) the pseudorhipidion is slightly twisted and extends for almost half the length of the glans; it is divisible into two areas: proximally the dorsal marginal is covered by loose, fleshy skin, but distally the integument becomes tightly bonded to the cartilage, so that the median, expanded region of the pseudorhipidion is exposed as a sharp cartilage.

Although Ishiyama (1958) distinguishes a pseudorhipidion in several Japanese rajids and restricts its occurrence to the genus *Bathyraja* (Ishiyama & Hubbs 1968), a pseudorhipidion has not been distinguished in the South African *Bathyraja smithii*. It should be noted, however, that in this species the dorsal marginal cartilage extends well into the clasper glans and has a raised lip on its outer lateral margin (Fig. 29); this would correspond to the pseudorhipidion, if it were developed externally.

(6) *pecten* (Leigh-Sharpe)

A cartilaginous structure located on the outer lateral margin of the dorsal lobe of the glans, at about the level of the hypopyle; it consists of six or more sharp, comb-like processes and is associated with the degree of development of the dorsal terminal 2 or dorsal terminal 3 cartilage.

The pecten is present in *Raja alba* and *R. miraletus* (Hulley 1970: figs 8, 9, cm). In *Raja straeleni*, the dorsal terminal 2 (Fig. 18 g) bears a number of small, blunt protuberances, corresponding in position to the pecten. These do not penetrate the integument of the outer wall of the clasper, and therefore do not manifest themselves as a pecten in this species. Stehmann (1971a) recognizes a pecten in *Raja herwigi*, which is formed in the same way as in *R. miraletus*.

(7) *dermal denticles* (new term)

Dermal denticles may be present on the outer border of the dorsal lobe of the clasper, where they may be close-set or widely separated.

Dermal denticles are present in *Rhinobatos annulatus*, *Raja confundens*, *R. leopardus* and *R. wallacei* (Figs 7, 13; Hulley 1970: figs 17-19) on the outer surface of the dorsal lobe. In *Cruriraja triangularis* (Fig. 8) they are developed on the ventral lobe of the glans. The term dermal denticles is discussed above in relation to the term scale.

(8) *ridge* (Ishiyama)

The ridge is the thickened and somewhat raised outer lateral border of the dorsal lobe; it extends from about the level of the hypopyle almost to the distal end of the clasper; it is directly related to the degree of development of the outer lateral edge of the dorsal terminal 2 cartilage.

The ridge is present in a single species only, *Bathyraja smithii* (Hulley 1970: fig. 21), in which it appears to be somewhat pleated and does not develop scale.

(9) *spur* (Leigh-Sharpe)

A hard, cartilaginous element, arising on the outer lateral margin of the dorsal lobe at about the level of the rhipidion, and curving outwards; it is formed by the dorsal terminal 3 cartilage, which appears to be movable, so that when the clasper glans is opened it protrudes from the outer lateral margin.

A spur is present in *Raja radiata*, *R. wallacei* and *Anacanthobatis marmoratus* (Figs 6, 7, 10). Although the sharp point of the dorsal terminal 3 cartilage did not protrude through the integument of the outer wall of the cleft in the type of *Raja wallacei* (Hulley 1970: fig. 19), examination of the cartilages revealed the hooked dorsal terminal 3 cartilage. Further material of this species, which has only just come to hand, confirms the presence of the spur (Fig. 7).

(10) *thorn* (new term)

A structure consisting of one or more small, sharp points, situated on the outer lateral margin of the dorsal lobe, at about the level of the hypopyle; it is formed directly from processes developed on the proximo-lateral edge of the dorsal terminal 1 cartilage.

A thorn has been found in *Cruriraja parcomaculata*, *C. triangularis* and *C. rugosa* (Figs 8, 9; Hulley 1970: fig. 4).

(11) *promontory* (Leigh-Sharpe)

A cartilaginous element situated at the proximal end of the cleft; it consists of a cartilaginous tongue, which is more or less covered by a thick layer of integument; it is formed by the distal projection of the dorsal terminal 2 cartilage.

A promontory has been found only in *Raja wallacei* (Fig. 7), where it arises at the medial region of the dorsal lobe and projects into the cleft.

(12) *roll* (Stehmann)

A fleshy structure situated in the proximo-lateral region of the dorsal lobe and orientated to run parallel to the outer margin; it is associated with the promontory and probably arises as a fleshy expansion of the proximal end of the dorsal terminal 3 cartilage.

A roll has been found only in *Raja wallacei* (Fig. 7).

Components of the ventral lobe

It should be noted that while certain structures are developed on the outer surface of the dorsal lobe (pseudosiphon, pecten, dermal denticles), no components are developed on the outer surface of the ventral lobe in Rajoidea, except for dermal denticles in *Cruriraja triangularis* (Fig. 8 B). However, in some Batoidei a blindly ending cavity, which has been termed the ventral pseudosiphon, because of its relation with the dorsal terminal 1 cartilage, is present (Fig. 12). The following structures are therefore all found within the glans:

(1) *shield* (Leigh-Sharpe)

An elongate, plate-like structure, extending along the outer lateral edge of the ventral lobe, from about the level of the hypopyle; it may be dorsally convex and covered by pleated epithelia, except along its outer lateral margin, which is sharp-edged; it is directly associated with the degree of development of the outer lateral margin of the ventral terminal cartilage.

With the exception of *Bathyraja smithii* (Hulley 1970: fig. 21) and *Anacanthobatis americanus* (Fig. 11), a shield is present in all the examined rajoids. However, it was found to be absent in other Batoidei.

In the majority of rajids, the shield extends from about the level of the hypopyle to the distal tip of the clasper, and may be covered entirely by pleated epithelia, e.g. *Raja doutrei*, *R. lanceorostrata*, *R. alba*, *R. miraleetus* (Hulley 1970: figs 5, 8, 9; Fig. 5) or covered only on its distal half with pleated epithelia, e.g. *Cruriraja parcomaculata*, *C. triangularis*, *C. rugosa*, *Raja caudaspinosa*, *R. confundens*, *Anacanthobatis marmoratus* (Figs 8, 9, 10; Hulley 1970: figs 4, 7, 17). In *Raja clavata* (Hulley 1970: fig. 10), unlike in *R. straeleni* (Hulley 1970: fig. 11), the shield is not well developed.

(2) *rhipidion* (Ishiyama)

An elongate, fan-shaped structure, consisting of porous, erectile tissue, which is situated on the inner border of the ventral lobe, and extends in the longitudinal axis of the clasper, from about the level of the hypopyle to about half the length of the glans; it is not associated with any cartilaginous element.

The rhipidion is elongate and free in *Raja doutrei*, *R. lanceorostrata*, *R. pullo-punctata*, *R. caudaspinosa*, *R. radiata*, *R. dissimilis*, *R. confundens*, *R. leopardus*,

R. wallacei, *Anacanthobatis americanus* and *A. marmoratus* (Figs 5, 6, 10, 11; Hulley 1970: figs 5–7, 15, 17–19), but is small, triangular and fixed in *Cruriraja parcomaculata*, *C. triangularis* and *C. rugosa* (Figs 8, 9; Hulley 1970: fig. 4).

(3) *boss* (new term)

A small, flattened, cartilaginous process, which is situated just below the rhipidion, and more medially than the knob; it is directly related to the development of a recurved lateral process of the accessory terminal 2 cartilage.

The boss has been found in a single species only, *Cruriraja parcomaculata* (Hulley 1970: fig. 4). Although a small process is developed on the accessory terminal 2 cartilage in both *Cruriraja rugosa* and *C. triangularis* (Fig. 27), the corresponding boss is not present as an external structure in the glans (Figs 8, 9).

(4) *knob* (new term)

A process, or processes, situated medially to the shield at about one-half the length of the clasper glans; it consists of a number of flattened processes (usually 4), or a single, plate-like cartilaginous element, from which a laterally directed, sharp, recurved point arises; the knob is related to the development of processes on the medio-dorsal side of the accessory terminal 1 cartilage.

The knob was so called to describe the blunt protuberances found in *Cruriraja parcomaculata* (Hulley 1970: fig. 4), but is now defined so as to include the plate and laterally projecting point in *C. triangularis* (Fig. 8) and the single, flattened process in *C. rugosa* (Fig. 9).

(5) *eperon* (Leigh-Sharpe)

A sharp, anteriorly directed, spur-like structure, which is situated proximally to the level of the hypopyle on the outer lateral margin of the clasper; it is an anterior projection of the ventral terminal cartilage and may be interpreted as the sharp apex of the shield.

An eperon is found in *Cruriraja parcomaculata*, *C. rugosa* and *Anacanthobatis marmoratus* (Figs 9, 10; Hulley 1970: fig. 4) and although Hulley (1970) pointed out that it is absent in *Cruriraja triangularis*, examination of further material has revealed that the eperon is present in this species.

In *Cruriraja triangularis*, *C. rugosa* and *Anacanthobatis marmoratus*, the eperon appears to be associated with the development of small processes or sharp serrations on the outer lateral edge of the shield. However, in *Cruriraja parcomaculata* the shield is smooth-edged.

The structure was first described by Leigh-Sharpe (1924) to cover a process in two South American species, *Raja cyclophora* and *R. platana*.

(6) *spike* (Leigh-Sharpe)

A cartilaginous element of varying size and shape, which is covered by integument and is located in the distal region of the glans; it is formed by the distal tip of the accessory terminal 2 cartilage.

A spike was found to be present in all the species of Rajoidea examined, except *Raja alba* and *Bathyraja smithii*, and was found to be absent in the Rhinobatidae and Myliobatoidea.

In *Cruriraja parcomaculata*, *C. triangularis* and *C. rugosa* (Figs 8, 9; Hulley 1970: fig. 4), the spike resembles a flattened, leaf-like tongue, which is situated on the median axis of the clasper. In *Raja doutrei* and *R. pullopunctata* (Hulley 1970: figs 5, 6) the spike is also medially placed, but is sharp-pointed and straight, while in *R. lanceorostrata* (Fig. 5) it is hooked. The sentinel obscures the spike in *R. miraletus* and *R. radiata*. The spike in *R. miraletus* is somewhat sharp-pointed, but in *R. radiata* it is more or less bilobed. A bulbous, bilobed spike is found in *R. confundens* (Hulley 1970: fig. 17), while in *R. wallacei* (Fig. 7) the spike is bilobed and elongate. A simple, bulbous spike, which in some cases appears to arise from the dorsal lobe of the glans, is found in *R. caudaspinosa*, *R. dissimilis* and *R. leopardus* (Hulley 1970: figs 7, 15, 18). A distally situated, sharp-pointed spike, forming a border to the sentina is found in *R. straeleni* and *R. clavata* (Hulley 1970: figs 10, 11). *Anacanthobatis marmoratus* and *A. americanus* (Figs 10, 11) possess a somewhat similarly shaped spike, which in *A. americanus* is directed laterally outward.

(7) sentinel (Leigh-Sharpe)

A cartilaginous structure, varying considerably in shape and size and which may or may not be covered by fleshy integument, located on the midline of the clasper; it is formed by the distal region of the accessory terminal 1 cartilage.

This structure is present in all species of Rajoidea except *Bathyraja smithii* and *Raja pullopunctata* and in Rhinobatidae and Myliobatoidea. It should be noted that the terms knife and claw, which are also developed from the accessory terminal, when only one accessory terminal cartilage is present, are used for *Bathyraja smithii*, Rhinobatidae and Myliobatoidea (cf. Stehmann, 1970).

The sentinel in the genus *Cruriraja* (Figs 8, 9; Hulley 1970: fig. 4) is a flattened, spatulate, cartilaginous structure, which is situated medially to the shield. An enlarged sentinel, with a sharp, knife-like, outer lateral edge is found in *Raja clavata* and *R. straeleni* (Hulley 1970: figs 10, 11); an enlarged, but spade-shape sentinel is found in *R. miraletus* (Hulley 1970: fig. 9); a curved, dorsally convex sentinel is found in *R. radiata* (Fig. 6); and an enlarged, elongate sentinel is found in *R. alba* (Hulley 1970: fig. 8), where it extends to the distal tip of the glans.

Raja doutrei and *R. pullopunctata* (Fig. 5; Hulley 1970: fig. 5) possess small, knob-like sentinels; in *R. dissimilis*, *R. confundens* and *R. leopardus* (Hulley 1970: figs 15, 17, 18) the sentinel is foot-like and may protrude laterally from the median axis of the glans; the sentinel in *R. wallacei* (Fig. 7) is bulbous, while in *R. caudaspinosa* (Hulley 1970: fig. 7) it is small and dorso-ventrally flattened.

The sentinel in *Anacanthobatis marmoratus* (Fig. 10) is tongue-like and quite dissimilar to the spike, but in *A. americanus* (Fig. 11) the sentinel resembles the spike, although it points laterally inward.

(8) signal (Leigh-Sharpe)

A fleshy pad, which is located posterior to the hypopyle at about the same level as the pseudorhipidion, and which can rotate about the longitudinal axis of the clasper; it is formed by the accessory terminal 3 and accessory terminal 4 cartilages.

The structure is present in *Raja clavata* and *R. straeleni* (Hulley 1970: figs 10, 11), where it is formed by both the accessory terminal 3 and 4 cartilages. It can rotate so as to protrude from the opened glans. In *Raja miraletus* (Hulley 1970: fig. 9) the signal is formed from a single cartilage only, the accessory terminal 3, and does not appear to be movable.

(9) *knife* (Ishiyama)

A movable, cartilaginous structure with an axe shape, which is covered by integument at its base, but exposed along its 'cutting' edge; it is situated in the distal region of the ventral lobe and is usually partly obscured by the projection; it is formed by the accessory terminal 1 cartilage.

A knife is present in a single species only, *Bathyraja smithii* (Hulley 1970: fig. 21), in which it is almost entirely obscured from view by the well-developed projection.

(10) *funnel* (Stehmann)

A bluntly-rounded, cartilaginous tongue, resembling the foot of a bivalve mollusc, which is situated at the distal region of the ventral lobe of the clasper, so as to extend beyond the cavity of the glans, when this is opened; it is formed by the elongate, distal end of the ventral terminal cartilage.

The funnel is found in the species *Raja clavata* and *R. straeleni* (Hulley 1970: figs 10, 11). Ishiyama (1958) is of the opinion that this structure is present in the Japanese genera *Bathyraja* and *Rhinoraja*, but this is incorrect (see discussion on terminology).

(11) *projection* (Stehmann)

An elongate, finger-like, cartilaginous rod, which is covered by integument and which projects from the ventral lobe; it is formed by the distal elongation of the ventral marginal cartilage.

A projection has been recognized in *Bathyraja smithii* (Hulley 1970: fig. 21), where it projects laterally inwards and obscures the underlying knife from view. It is thickly covered by integument, so as to resemble the funnel, but may easily be distinguished from that structure (see above).

(12) *sentina* (Leigh-Sharpe)

A blindly ending sac, whose aperture points posteriorly, and which is located at the distal end of the clasper; it may be associated with the distal tip of the accessory terminal 2 cartilage.

A sentina is present in *Cruriraja parcomaculata*, *Raja caudaspinosa*, *R. miraletus*, *R. clavata*, *R. straeleni*, *R. confundens* and *R. wallacei* (Hulley 1970: figs 4, 7, 9–11, 17, 19). It is not easily identifiable, and should not be confused with the ventral pseudosiphon.

(13) *claw* (Ishiyama)

A small, sharp, cartilaginous point, which is situated on the ventral lobe at about the level of the hypopyle; it is formed by the accessory terminal 1 cartilage and is usually associated with a ventral pseudosiphon.

Among the species which have been examined in detail, a claw has been found only in *Rhinobatos annulatus* and *Myliobatis cervus* (Figs 13, 14), but it may

well be present in other Rhinobatoidea and Myliobatoidea, e.g. *Rhinobatos ocellatus* (Fig. 12), *Rhinobatos schlegeli*, *Platyrhina sinensis* (Ishiyama 1958: fig. 20).

(14) *pent* (Leigh-Sharpe/Stehmann)

An elongate ridge, which is covered by pleated integument and runs from the distal end of the rhipidion, parallel with the mid-line of the clasper; it is a fleshy structure, which is associated with the inner lateral edge of the ventral terminal cartilage.

A pent has been recognized in *Raja dissimilis*, *R. confundens*, *R. wallacei* and *R. radiata* (Figs 6, 7; Hulley 1970: figs 15, 17 (not labelled)), and may also be present in *R. caudaspinosa* and *R. leopardus*.

The skeleton of the clasper is a continuation, in the median axis, of the basipterygium, and is composed of three groups of cartilages, the basal group (including the basipterygium), the axial group and the terminal group.

Basal group

The basal group consists of three types of cartilages (Fig. 15): the basipterygium (B), the Beta-cartilage and a varying number of intermediate proximal segments (b_1-b_3). Ishiyama (1958) has pointed out that the basal group is not species specific, and although the number of proximal segments may vary within large groups of elasmobranchs (Huber 1901), the basal group may only be used in the interpretation of phylogenetic relationships (White 1937).

Huber (1901) pointed out that in the Platosomeae (Batoidei) the number of proximal segments varies between two and four. Ishiyama (1958) found that there are four intermediate segments in Platyrhinidae (*Platyrhina sinensis*), three in Rhinobatidae (*Rhinobatos schlegeli*), and only two in *Raja*, *Bathyraja* and *Rhinoraja* among the Rajidae, and on this basis has postulated that the Rhinobatidae are intermediate between the Platyrhinidae and the Rajidae. Some criticism of this theory may be raised by the fact that Jungersten (1899) and Huber (1901) recorded four intermediate segments in *Rhinobatos columnae*, but the present investigation supports Ishiyama, in that only three intermediate cartilages are present in *Rhinobatos annulatus* (Fig. 15 a) and *Rhinobatos ocellatus*.

This investigation of the basal group of cartilages, while including *Raja* and *Bathyraja*, has been expanded to incorporate the genus *Cruriraja* of the family Rajidae and *Anacanthobatis* of the family Anacanthobatidae, so that an overall picture of the basal group in the Rajoidea may be obtained.

It appears that in the Rajoidea (Fig. 15), the basipterygium is connected to the axial cartilage by two intermediate segments (b_1-b_2), which are partially covered dorsally by a flat, plate-like Beta-cartilage, serving as an area of attachment for the *m. flexor internus* (Jungersten 1899; Hulley 1966). Unlike the Rhinobatidae, the Beta-cartilage in the Rajoidea does not extend on to the axial cartilage, but terminates above the junction of the b_2 —and axial cartilages (Fig. 15).

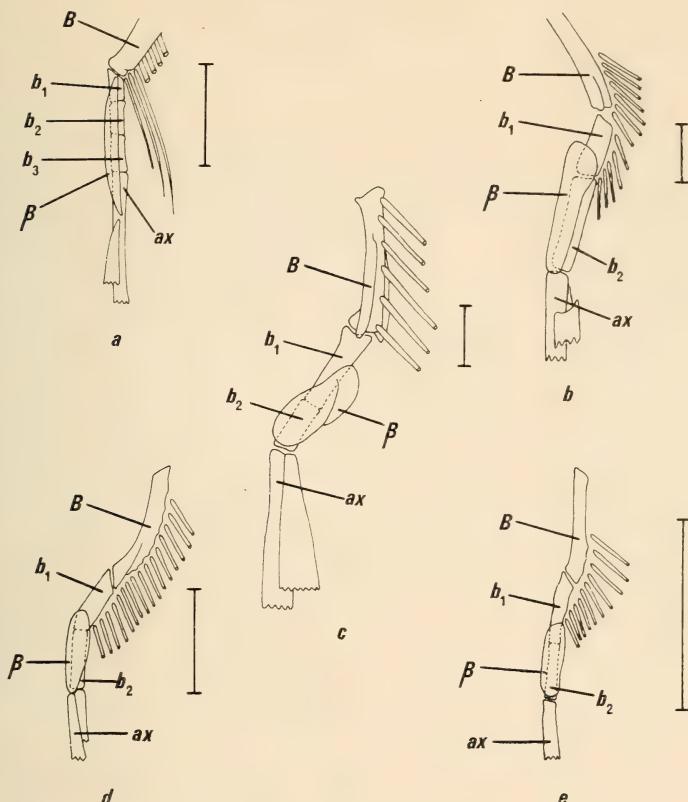


Fig. 15. Intermediate proximal segments of the claspers. a. *Rhinobatos annulatus*; b. *Bathyraja smithii*; c. *Raja clavata*; d. *Cruriraja parcomaculata*; e. *Anacanthobatis americanus*. Scale 2,0 cm.
B – basipterygium; b_1 , b_2 , b_3 – intermediate segments; β – beta cartilage; ax – axial cartilage.

Axial and terminal groups

The axial, dorsal marginal and ventral marginal cartilages are included in the axial group, but as it is the distal regions of these cartilages which are important, and since they extend into the terminal complex, they are described under this heading. The terminal group consists of three different types of cartilages: dorsal terminal cartilages, a series situated dorsally to the axial, to which some are joined; the ventral terminal cartilage, a single element which is ventrally situated and overlies the accessory terminals; the accessory terminal cartilages (Hulley 1966: fig. 3 G). The number of cartilages in the terminal group varies between seven and ten.

Huber (1901) and White (1937) suggest that the terminal (accessory) structures are constant within large groups of elasmobranchs, and Ishiyama

(1958) has discussed the specificity and evolutionary significance of the terminal group in Japanese rajids.

(1) axial cartilage

The axial cartilage, which is usually much less calcified than the other cartilages, forms the basic foundation of the clasper. At its junction with the b_2 - and Beta-cartilages, it is almost cylindrical in cross-section, and it extends as a bar-like cartilage to terminate at the distal end of the clasper. From its proximal end to the level of the commencement of the glans, the axial is nearly completely enclosed by dorsal and ventral marginal cartilages, so as to form a tube on the outer lateral surface of the axial. This tube is the clasper groove.

The distal end of the axial cartilage is bluntly pointed in *Rhinobatos annulatus*, *Anacanthobatis americanus*, *Bathyraja smithii*, *Raja straeleni* and *R. clavata* (Figs 29, 32, 44, 45; Hulley 1966: fig. 3), but is expanded and spatulate in *Raja lanceorostrata*, *R. pullospunctata*, *R. doutrei*, *R. radiata*, *R. wallacei*, *R. confundens*, *R. caudaspinosa*, *R. leopardus*, *R. miraletus*, and *Myliobatis cervus* (Figs 30–31, 34–39, 46; Hulley 1966: fig. 5; 1969: fig. 3). In *Cruriraja parcomaculata*, *C. rugosa*, *C. triangularis* and *Anacanthobatis marmoratus* (Figs 40–43) the distal end is expanded laterally and recurved to form a J-shaped cartilage. The well-developed lateral expansion of the axial in *Raja alba* (Fig. 33) is not formed in a similar manner, and should rather be seen as further development of the spatulate type, through some intermediary like *Raja miraletus*.

(2) dorsal marginal cartilage

The dorsal marginal cartilage attaches tightly to the axial, starting where the axial is connected to the b_2 /Beta joint, and runs along the outer lateral margin of the axial. Proximally, the cartilage is somewhat broadly pointed, but the distal region is characteristically expanded. Three different types may be recognized: the dorsal marginal may be truncate at its junction with the dorsal terminal 2 cartilage as in *Raja caudaspinosa*, *R. dissimilis*, *R. confundens*, *R. leopardus*; it may be asymmetrically bifurcate, with the larger of the two limbs developed from the inner lateral edge as in *Raja doutrei*, *R. pullospunctata*, *R. lanceorostrata*, *R. radiata*, *R. wallacei*, *Anacanthobatis americanus* and *Myliobatis cervus*; or may possess a marked distal elongation as in *Raja alba*, *R. clavata*, *R. straeleni*, *R. miraletus* and *Bathyraja smithii* (Figs 29, 32, 33; Hulley 1966: fig. 3; 1969: fig. 3). The distal elongation of the dorsal marginal into the clasper forms the dorsally situated pseudorhipidion. The extension is best developed in *Raja alba* (Fig. 33), where it narrows proximally, but becomes expanded distally and terminates in a blunt point at about half the length of the clasper glans. The distal elongation is shorter in *Raja miraletus* and is stepped to accommodate the dorsal terminal 2 cartilage (Hulley 1969: fig. 3). In *Raja clavata* and *R. straeleni*, it is only slightly stepped (Fig. 32; Hulley 1966: fig. 3).

A modified form of asymmetrically bifurcate type is found in the genus *Cruriraja* (Figs 40–42) and in *Anacanthobatis marmoratus*. In these species, it is the

outer lateral edge which is elongate. This elongation is bluntly rounded in *Cruriraja parcomaculata* and *C. triangularis*, but is truncate in *C. rugosa*.

In *Rhinobatos annulatus* (Fig. 45) the dorsal marginal cartilage terminates in a bluntly rounded point.

(3) ventral marginal cartilage

The ventral marginal cartilage, unlike the dorsal marginal, arises some little distance posteriorly to the axial and b_2/β junction. It is a flat, tongue-like structure, whose outer lateral edge forms the ventral margin of the clasper groove. It extends further along the length of the clasper than the dorsal marginal cartilage, and distally is usually expanded and ventrally convex.

In the majority of the species examined, the terminal end of the ventral marginal cartilage is evenly curved. However, in *Bathyraja smithii* (Fig. 29) the outer lateral edge of the ventral marginal is elongate, extending almost to the distal end of the clasper. This distal prolongation of the cartilage forms the projection in the clasper glans.

The genus *Anacanthobatis* is unusual in that the distal end of the ventral marginal is truncate in *A. americanus* (Fig. 44), as it is in *Myliobatis cervus* (Fig. 46), and is anteriorly arched in *A. marmoratus*.

(4) dorsal terminal 1 cartilage

The dorsal terminal 1 cartilage ('cover-piece' of Junghersen 1899) is situated on the dorsal side of the clasper glans, usually partially overlying the other dorsal terminal cartilages. Ishiyama (1958), besides pointing out the species specificity of this cartilage, has shown that phylogenetic relationships may be based on its degree of development and orientation, together with its associated structure, the pseudosiphon. The pseudosiphon develops as a blindly ending sac, underlying the dorsal terminal 1. Dorsally the dorsal terminal 1 is flat and shield-like, but in some species it may be strongly curved medially to wrap around the inner margin of the axial cartilage. The *m. dilatator* is attached to the proximal edge of the dorsal terminal 1, but in *Raja miraletus*, *R. straeleni* and *R. clavata*, there is a proximal shelf (Figs 16 g-h), which serves as the area of attachment of the muscle. A smaller shelf is found in *Bathyraja smithii* (Fig. 16 a).

In the Rhinobatidae, e.g. *Rhinobatos annulatus* (Fig. 17 a) and *Rhinobatos schlegeli* (Ishiyama 1958: fig. 20), the dorsal terminal 1 is wholly situated on the ventral surface of the clasper, and is associated with the development of both the dorsal pseudosiphon and the ventral pseudosiphon. Similarly, in *Myliobatis cervus*, the dorsal terminal 1 is ventro-laterally positioned.

While the dorsal terminal 1 is dorsally situated in *Anacanthobatis marmoratus* (Fig. 17 g), it is positioned laterally in *A. americanus* (Fig. 17 h), so that the major portion of the cartilage is situated on the ventral surface of the clasper.

Amongst the Rajidae, seven types of dorsal terminal 1 cartilage may be distinguished. In *Bathyraja smithii* (Fig. 16 a), the dorsal terminal 1 is dorsally

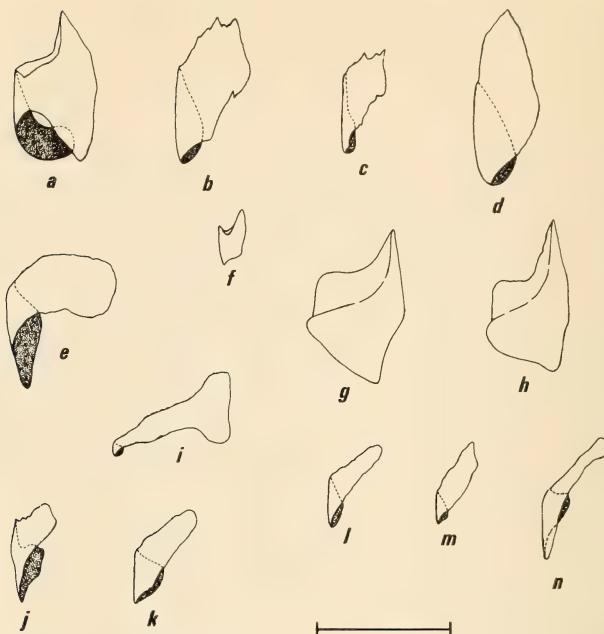


Fig. 16. Dorsal view of dorsal terminal I cartilages. Scale 4.0 cm.

a. *Bathyraja smithii*; b. *Raja doutrei*; c. *R. lanceorostrata*; d. *R. pullo punctata*; e. *R. alba*; f. *R. miraletus*; g. *R. clavata*; h. *R. straeleni*; i. *R. radiata*; j. *R. confundens*; k. *R. leopardus*; l. *R. dissimilis*; m. *R. caudaspinosa*; n. *R. wallacei*.

situated and shield-like, but it is markedly curved laterally and wraps around on to the ventral side, cf. *Bathyraja diplotaenia*, *B. parmafera* (= *B. simoterus*), *B. smirnovi* (Ishiyama 1958: fig. 8); in *Raja doutrei*, *R. lanceorostrata* and *R. pullo punctata* (Figs 16 b-d), the dorsal terminal I is shield-like dorsally, but is not so markedly curved along the inner lateral margin, and does not have the proximal shelf for the insertion of the *m. dilatator*; the dorsal terminal I in *Raja alba* (Fig. 16 a) is unique amongst the species examined in that curvature is well developed, while the dorsal area runs as a transverse band to the outer edge of the clasper; the cartilage in the species *Raja confundens*, *R. leopardus*, *R. dissimilis*, *R. caudaspinosa* and *R. wallacei* (Figs 16 j-n) have been classed together and appear to be not too different from that of *Raja alba*, but in these species the dorsal region of the cartilage is directed proximally; in *Raja radiata* (Fig. 16 i), there is virtually no ventral curvature, but the dorsal region of the cartilage is large and directed proximally, with an enlarged, hammer-shaped, outer lateral margin. The dorsal terminal I in *Raja miraletus*, *R. clavata* and *R. straeleni* (Figs 16 f-h) is carried almost entirely on the dorsal surface as a well-developed, shield-like structure with a proximal shelf. The similarity between the cartilages of *Raja clavata* and *R. straeleni* is marked.

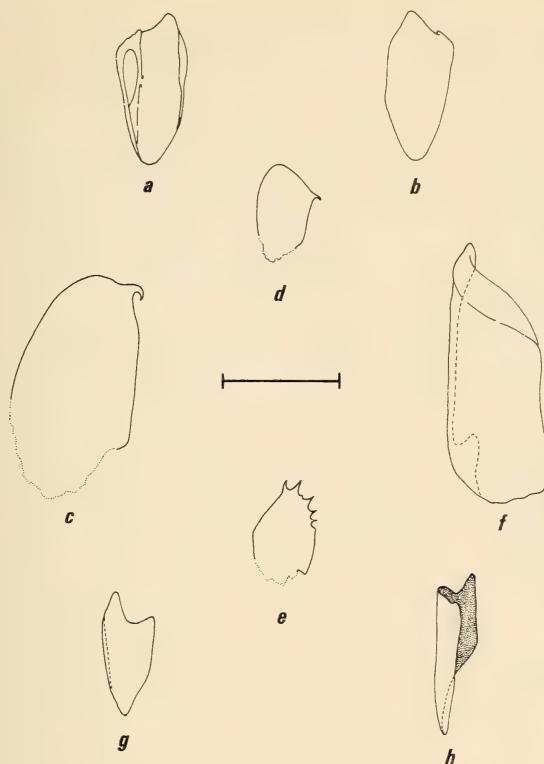


Fig. 17. Dorsal view of dorsal terminal 1 cartilage.
Scale 1,0 cm.

- a. *Rhinobatos annulatus*; b. *R. annulatus* (ventral view);
- c. *Cruriraja parcomaculata*; d. *C. triangularis*; e. *C. rugosa*;
- f. *Myliobatis cervus*; g. *Anacanthobatis marmoratus*;
- h. *A. americanus*.

A different type of cartilage is possessed by the genus *Cruriraja* (Figs 17 c–e). In this, the dorsal terminal 1 is situated within the short arm of the J-shaped axial, and only partially overlaps the dorsal terminal 2 proximally, so that the cartilage forms the dorsal wall of the clasper glans. Sharp points are developed on the proximo-lateral edge of the dorsal terminal 1, which are directly related to, and responsible for, the development of the thorn. A simple point is found in *Cruriraja parcomaculata* and *C. triangularis*, while a series of points is found in the North American species *C. rugosa*.

(5) dorsal terminal 2 cartilage

The dorsal terminal 2 is situated along the proximal dorsal border of the glans and is joined to the distal region of the dorsal marginal cartilage, or fits into a step in that cartilage, when the dorsal marginal has a well-developed distal extension (Hulley 1969: figs 3 A, C). The dorsal terminal 2, together with

the dorsal terminals 3 and 4 (when present), extend distally as bar-like elements and form the framework of the dorsal lobe. Short, sharp processes may be developed on the outer lateral margin of the dorsal terminal 2, and these may protrude through the thin integument as the pecten.

The dorsal terminal 2 cartilage in *Rhinobatos annulatus* (Fig. 19 a) is not connected to the distal end of the dorsal marginal, but is tightly bonded along the inner lateral margin of that cartilage (Fig. 45). It is only slightly convex dorsally. A dorsally convex dorsal terminal 2 is also found in *Myliobatis cervus* (Fig. 19 d), but in this species it develops from the distal end of the dorsal marginal (Fig. 46).

As with the dorsal terminal 1, the dorsal terminal 2 cartilage can be divided into six types, although the grouping does not correspond with that of the dorsal terminal 1.

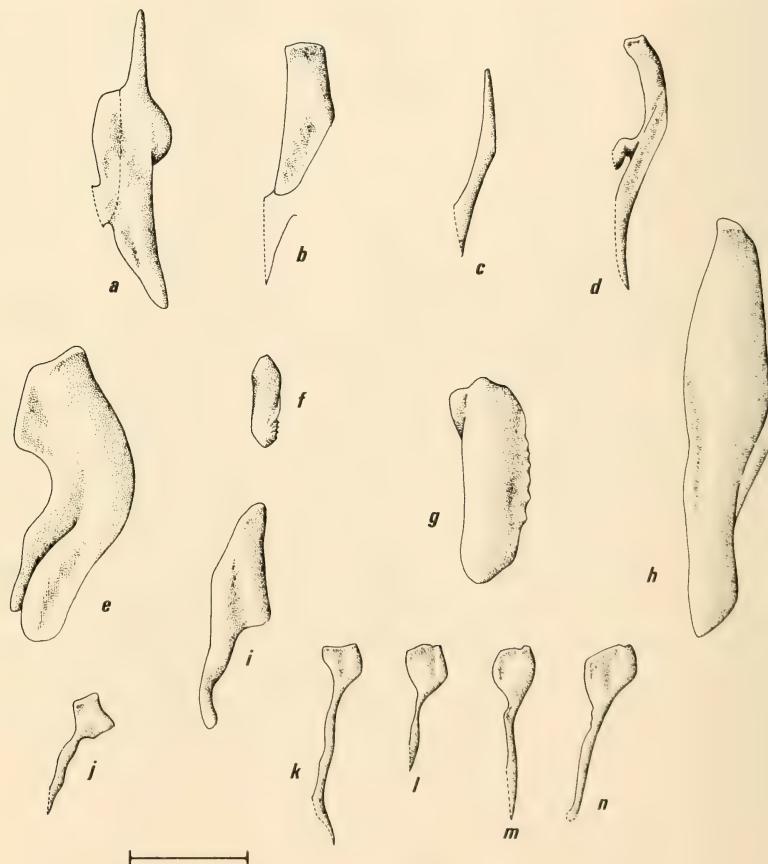


Fig. 18. Dorsal view of dorsal terminal 2 cartilage. Scale 2,0 cm.

- a. *Bathyraja smithii* (dorsal terminal 2 and 3); b. *Raja doultriei*; c. *R. lanceostrata*;
- d. *R. pullo punctata*; e. *R. clavata*; f. *R. miraletus*; g. *R. straeleni*; h. *R. alba*;
- i. *R. wallacei*; j. *R. radiata*; k. *R. dissimilis*; l. *R. caudaspinosa*; m. *R. confundens*;
- n. *R. leopardus*.

In *Bathyraja smithii* (Fig. 18 a) the dorsal terminal 2 arises at the distal end of the dorsal marginal and runs distally for a short distance, before turning laterally inward to become fused to the axial cartilage. Closely approximating to this type is the dorsal terminal 2 in *Raja pullopunctata*, *R. doutheti* and *R. lanceostrata* (Figs 18 b-d), which becomes narrower proximally, to form a bar-like element. In *Raja doutheti* and *R. pullopunctata*, a short, cartilaginous bridge (terminal bridge) is developed, which attaches the dorsal terminal 2 to the axial. In *Raja lanceostrata* (Fig. 31) the dorsal terminal 2 itself makes contact with the axial. A dorsal terminal 2/axial junction is also shown by the species *Raja radiata*, *R. dissimilis*, *R. caudaspinosa*, *R. confundens* and *R. leopardus* (Figs 18 j-n, 34, 36-39), but in these species the proximal end of the dorsal terminal is expanded, while the distal end is contracted. Although the dorsal terminal 2 is not attached to the axial in *Raja wallacei* (Figs 18 i, 35), it is similarly shaped. In this species the free end of the cartilage is responsible for the formation of the promontory. In *Raja miraletus* and *R. straeleni* the dorsal terminal 2 is flat and shield-like, with a series of protuberances situated on its outer lateral edge. An elongate cartilage is found in *Raja alba* (Fig. 18 h),

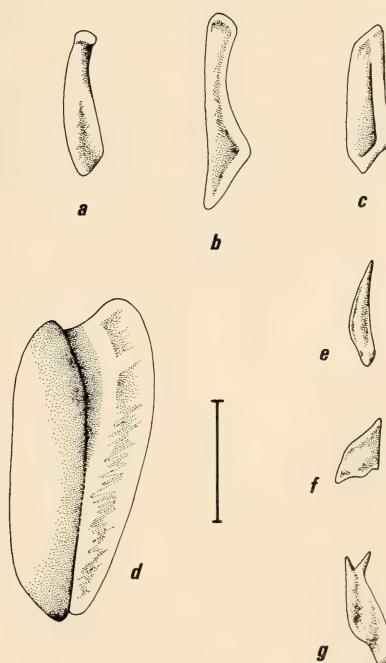


Fig. 19. Dorsal view of dorsal terminal 2 cartilage. Scale 1.0 cm.

- a. *Cruiraja triangularis*; b. *C. parcomaculata*;
- c. *C. rugosa*; d. *Myliobatis cervus*; e. *Rhinobatos annulatus*;
- f. *Anacanthobatis marmoratus*;
- g. *A. americanus*.

which is similar to the cartilage in *R. miraletus* and *R. straeleni* (Figs 18 f, g), but does not form lateral processes. The dorsal terminal 2 is strongly curved in *Raja clavata* (Fig. 18 e) and is thickened along its side of greatest curvature, to form a flat ledge, which articulates with the dorsal terminal 1 cartilage. Although the dorsal terminal 2 appears to be species specific in *Cruriraja* species, they are of the same general type and are quite different from the structure of the cartilage in *Raja* species.

In the genus *Cruriraja*, the dorsal terminal 2 is a short and slightly curved bar-like element, which arises at the distal end of the dorsal marginal and terminates in a truncate tip, within the curvature offered by the dorsal terminal 1 (Figs 40-42).

As with the dorsal terminal 1, the dorsal terminal 2 cartilage in *Anacanthobatis marmoratus* (Fig. 19 f) and *A. americanus* (Fig. 19 g) is very dissimilar. In *A. marmoratus*, the dorsal terminal 2 is truncate and plate-like, while in *A. americanus* the proximal end of the tongue-like cartilage is bifurcate and the distal end is free and protrudes laterally from the axial.

(6) dorsal terminal 3 cartilage

This cartilage was found to be absent in *Cruriraja parcomaculata*, *C. triangularis*, *C. rugosa*, *Raja pullospunctata*, *R. miraletus*, *R. clavata*, *R. straeleni* and *Anacanthobatis americanus*.

In Rajidae, the dorsal terminal 3 extends distally from the dorsal terminal 2 cartilage and may either have a free, distal end, as in *Raja caudaspinosa*, *R. confundens*, *R. dissimilis*, *R. leopardus*, *R. wallacei* and *R. radiata* (Figs 20 c-h, 34-39),

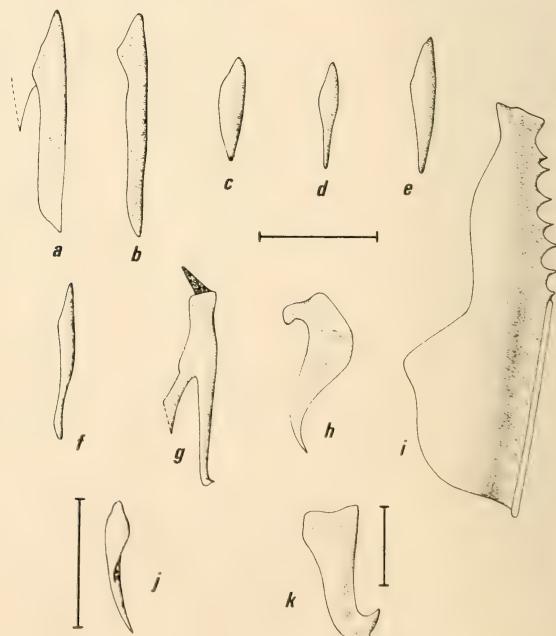


Fig. 20. Dorsal view of dorsal terminal 3 cartilage. Scale 2,0 cm.
 a. *Raja doutei*; b. *R. lanceostrata*;
 c. *R. caudaspinosa*; d. *R. dissimilis*;
 e. *R. confundens*; f. *R. leopardus*;
 g. *R. wallacei*; h. *R. radiata*;
 i. *R. alba*; j. *Rhinobatos annulatus* (scale 0,5 cm); k. *Anacanthobatis marmoratus* (scale 0,5 cm).

or the distal end may be fused to the expanded terminal end of the axial cartilage, as in *Raja doutrei* and *R. lanceorostrata* (Figs 20 a–b, 31, 32).

The dorsal terminal 3 cartilage in *Bathyraja smithii* (Fig. 18 a) is not firmly attached to the bluntly pointed axial. However, it is tightly bonded to the dorsal terminal 2 along its inner lateral margin, while its somewhat thickened, outer lateral edge forms the ridge in the clasper glans. The dorsal terminal 3 in *Raja lanceorostrata* and *R. doutrei* (Figs 20 a, b) is flat and spatulate, and arises either from the terminal bridge (*R. doutrei*) or directly from the dorsal terminal 2 (*R. lanceorostrata*).

The 'free-ended' dorsal terminal 3 species consist of two groups: (i) the distal region of the cartilage is curved laterally outward in a sharp point, forming the spur in *Raja radiata* and *R. wallacei* (Figs 34, 35); (ii) the cartilage is straight, and the free end is bluntly pointed, as in *R. caudaspinosa*, *R. confundens*, *R. dissimilis*, and *R. leopardus* (Figs 36–39). In the latter group the cartilage forms the outer lateral border of the distal cleft.

In *Rhinobatos annulatus* (Fig. 20 j) the dorsal terminal 3 is simple, while in *Myliobatis cervus* (Fig. 19 d) the cartilage is flat and attached along its inner lateral margin to the dorsal terminal 2 (Fig. 46), as in *Bathyraja smithii*. A spur is formed by the dorsal terminal 3 in *Anacanthobatis marmoratus* (Fig. 20 k).

(7) dorsal terminal 4 cartilage

This cartilage is present only in *Raja alba*, *R. radiata*, *R. dissimilis*, *R. caudaspinosa*, *R. confundens*, *R. leopardus* and *R. wallacei* cf. *R. fyllae*, *R. fullonica* (Stehmann 1970)—see discussion. In all these species, the dorsal terminal 4 attaches the dorsal terminal 3 to the axial, so completing the dorsal framework. On the basis of the attachment of the dorsal terminal 4 to the dorsal terminal 3, the cartilages may be divided into two groups. In the first, the dorsal terminal 4 attaches to the dorsal terminal 3 externally, some little distance behind the

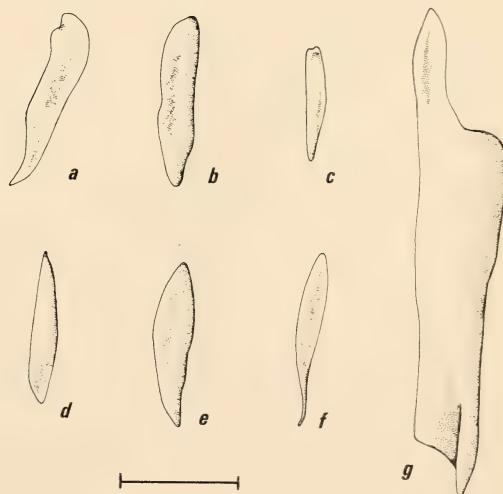


Fig. 21. Dorsal view of dorsal terminal 4 cartilage. Scale 2.0 cm.
a. *Raja radiata*; b. *R. wallacei*;
c. *R. caudaspinosa*; d. *R. confundens*;
e. *R. leopardus*; f. *R. dissimilis*;
g. *R. alba*.

dorsal terminal 3/dorsal terminal 2 junction, so that the distal end of the dorsal terminal 3 is free, e.g. *Raja radiata*, *R. caudaspinosa*, *R. confundens*, *R. dissimilis*, *R. leopardus* and *R. wallacei* (Figs 34–39). In the second group, e.g. *Raja alba* (Fig. 33), the dorsal terminal 4 is attached to the distal end of the dorsal terminal 3, thereby forming a link between this cartilage and the axial.

(8) ventral terminal cartilage

This cartilage was found to be absent only in *Anacanthobatis americanus*. The ventral terminal cartilage is located on the ventral side of the clasper, and extends from about the level of the distal end of the ventral marginal to the distal tip of the clasper. It therefore forms the ventral lobe of the clasper glans.

Amongst the Rajidae, *Bathyraja smithii* (Fig. 22 a) has the simplest ventral terminal cartilage. This is more or less spoon-shaped, with a somewhat pointed proximal extension and thickened distal region, so that it resembles the type usually associated with this genus (Ishiyama 1958: figs 10 B, E, F, H, I, L). The ventral terminal cartilages of *Raja doutei*, *R. pullopunctata* and *R. lanceostrata* have common characteristics and may be grouped together. In these species (Figs 22 b–d) the cartilage may be divided into three areas: the outer lateral margin is well developed and is dorsally convex, forming the shield of the glans; there is an anterior notch, which attaches to the accessory terminal 1 cartilage; the distal region is expanded on its inner lateral margin and this plate-like area folds around the axial, so that the ventral terminal attains a J-shape. The outer lateral margin is narrower and flat in *Raja miraletus*, *R. straeleni* and *R. clavata* (Figs 22 e–g), so that in these species the shield is not well developed. Although the medio-distal inner margin of the cartilage is expanded to wrap around the axial (Hulley 1966: fig. 3 G; Figs 22 e–g), the distal end of the cartilage is well developed and forms a structure which resembles the foot of a bivalve mollusc. This distal end forms the funnel of the glans. There is no anterior notch.

The ventral terminal in *Raja alba* (Fig. 22 h) appears to be unique in that, while the inner median lateral edge of the cartilage is expanded to curve around the axial cartilage, the outer lateral margin is well developed and dorsally convex.

Unlike the above, the ventral terminals in the following rajids are different in that neither the distal tip, nor the inner lateral margin are expanded to encompass the axial. The anterior notch, for attachment to the accessory terminal 1, is shifted posteriorly and is situated at about half the length of the cartilage. Furthermore, it is the proximal region of the ventral terminal which is expanded, and in the species *Raja caudaspinosa*, *R. confundens*, *R. dissimilis*, *R. leopardus* and *R. wallacei* (Figs 22 j–n) is characterized by an inner lateral expansion, cf. projection of *Raja linnea* (Leigh-Sharpe 1924: fig. 6). On the basis of the above, *Raja caudaspinosa*, *R. confundens*, *R. dissimilis*, *R. leopardus* and *R. wallacei* have been grouped together, and while *R. radiata* is somewhat similar, it has been kept separate because of its unique shape and its median notch (Fig. 22 i).

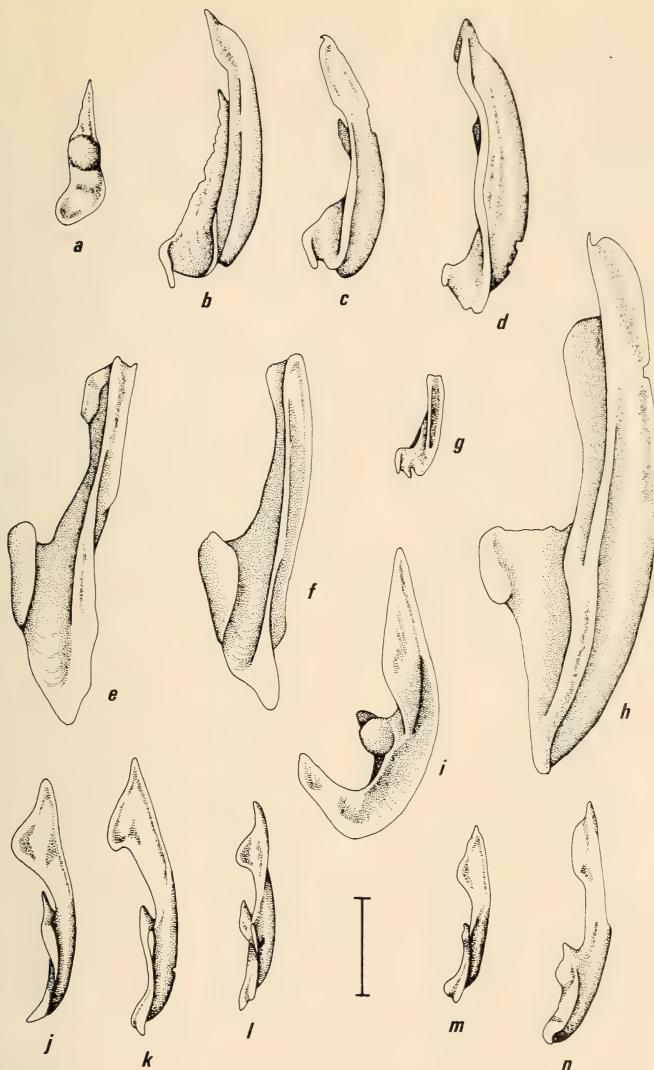


Fig. 22. Dorsal view of ventral terminal cartilage. Scale 2,0 cm.
 a. *Bathyraja smithii*; b. *Raja doutriei*; c. *R. lanceostrata*; d. *R. pullo-punctata*; e. *R. clavata*; f. *R. straeleni*; g. *R. miraletus*; h. *R. alba*; i. *R. radiata*; j. *R. confundens*; k. *R. leopardus*; l. *R. dissimilis*; m. *R. cauda-spinosa*; n. *R. wallacei*.

Once again the ventral terminal in the genus *Cruriraja* is more or less constant in shape, although it appears to be species specific. In these species (Figs 23 a-c), a point is developed on the proximal outer lateral edge of the narrow shield. This is the eperon. The notch is situated anteriorly in all, but in *C. triangularis* the distal region is bifurcate and in *C. rugosa* it is expanded.

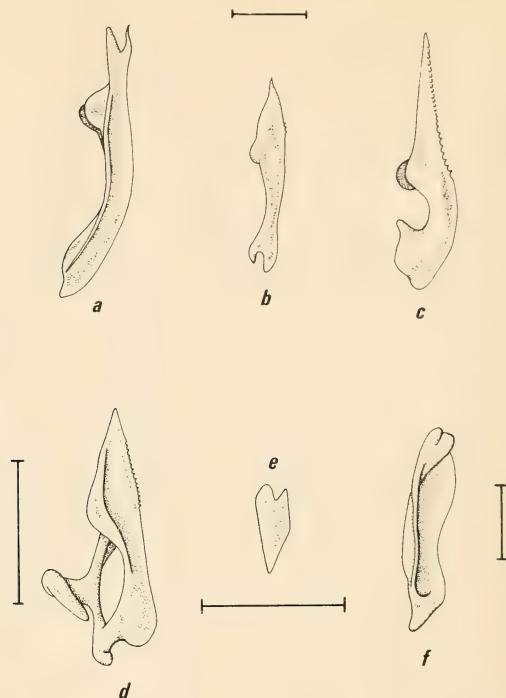


Fig. 23. Dorsal view of ventral terminal cartilage.
Scale 1,0 cm.
a. *Cruriraja parcomaculata*; b. *C. triangularis*; c. *C. rugosa*;
d. *Anacanthobatis marmoratus*; e. *Rhinobatos annulatus*;
f. *Myliobatis cervus*.

The ventral terminal in *Anacanthobatis marmoratus* (Fig. 23 d) is unusual. It possesses a well-developed outer lateral edge, which forms the shield, and which is serrate, as in some *Cruriraja* species. Medially the cartilage is expanded and runs around the axial, as in *Raja alba*. However, in *Anacanthobatis marmoratus* the inner lateral plate is windowed.

(9) accessory terminal 1 cartilage

In all Batoidei the accessory terminal 1 arises at the distal end of the ventral marginal cartilage, but its form in the Rhinobatoidea and Myliobatoidea (Figs 45, 46) is quite different from that in the Rajooidea, although the accessory terminal 1 in *Anacanthobatis marmoratus* and *A. americanus* resembles that of *Rhinobatos annulatus* (Figs 25 c-e) and *Myliobatis cervus* (Fig. 46), particularly in its sharp, pointed distal end. The accessory terminal 1 is closely associated with the accessory terminal 2, although in *Rhinobatos annulatus*, *Myliobatis cervus* and *Bathyraja smithii* only one accessory terminal cartilage is present. The distal end of the accessory terminal 1 has been termed the sentinel in all cases in which this cartilage manifests itself within the glans, except in the above-

mentioned species, in which it is variously termed claw and knife, depending on its degree of development, cf. Stehmann (1970). The distal end of the accessory terminal 1 cartilage varies in shape from elongate, sharp-pointed to expanded and flattened. In *Cruriraja* species, there is a lateral process, which develops at about half the length of the cartilage, in the form of the knob. This consists of a flattened protuberance in *C. rugosa* (Fig. 25 f), a series of four blunt lobes in *C. parcomaculata* (Fig. 25 a, a¹), or a sharp, recurved spine in *C. triangularis* (Fig. 25 b, b¹).

The accessory terminal in *Bathyraja smithii* (Fig. 24 a) is unusual and quite

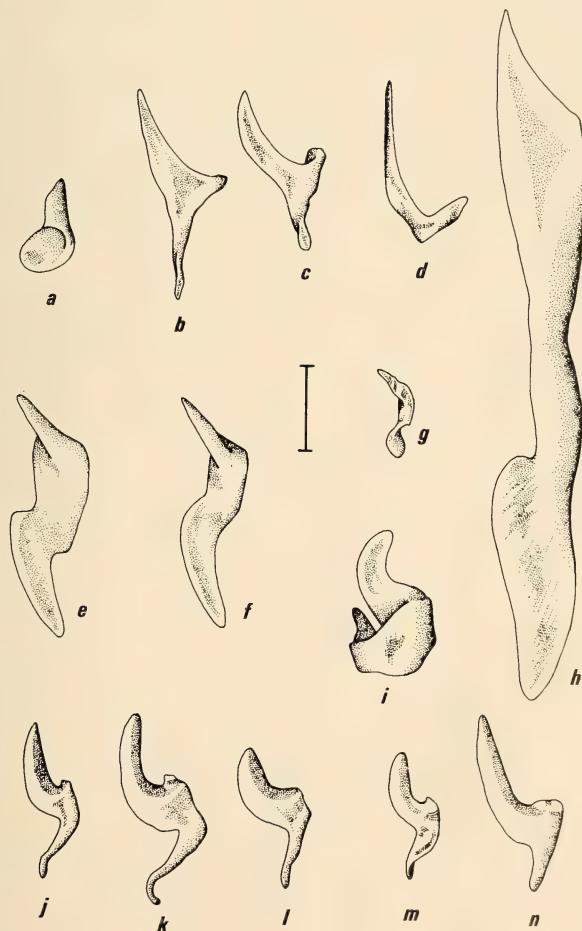


Fig. 24. Ventral view of accessory terminal 1 cartilage.

Scale 2.0 cm.

- a. *Bathyraja smithii*;
- b. *Raja doltrei*;
- c. *R. lanceostrata*;
- d. *R. pullopunctata*;
- e. *R. clavata*;
- f. *R. straeleni*;
- g. *R. miraleetus*;
- h. *R. alba*;
- i. *R. radiata*;
- j. *R. confundens*;
- k. *R. leopardus*;
- l. *R. dissimilis*;
- m. *R. caudaspinosa*;
- n. *R. wallacei*.

unlike the cartilage in other rajid species. The cartilage is fan-shaped with a blade-like posterior margin, similar in shape to the accessory terminal in *Rhinoraja odai* and *Rhinoraja longicauda* (Ishiyama 1958: fig. 11). In all other rajids, the accessory terminal 1 cartilage is Y-shaped, although in *Raja clavata*, *R. straeleni*, *R. miraletus* and *R. alba* (Figs 24 e-h) there appears to be a single arm. Ishiyama (1958) has commented on the change from a symmetrical to an asymmetrical shape.

Furthermore, Ishiyama (1958) has grouped the accessory terminal 1 according to the shape of the distal region of the cartilage. However, in this study the accessory terminal 1 has been grouped on the basis of general overall appearance. Excluding the species *Bathyraja smithii*, five types of cartilages can be identified in southern African rajids.

In *Raja pullo punctata*, *R. doutrei* and *R. lanceorostrata*, the cartilage is of asymmetrical Y-shape, with the posterior arm varying from elongate and pointed (*R. doutrei*, Fig. 24 b) to a small blunt process (*R. pullo punctata*, Fig. 24 d).

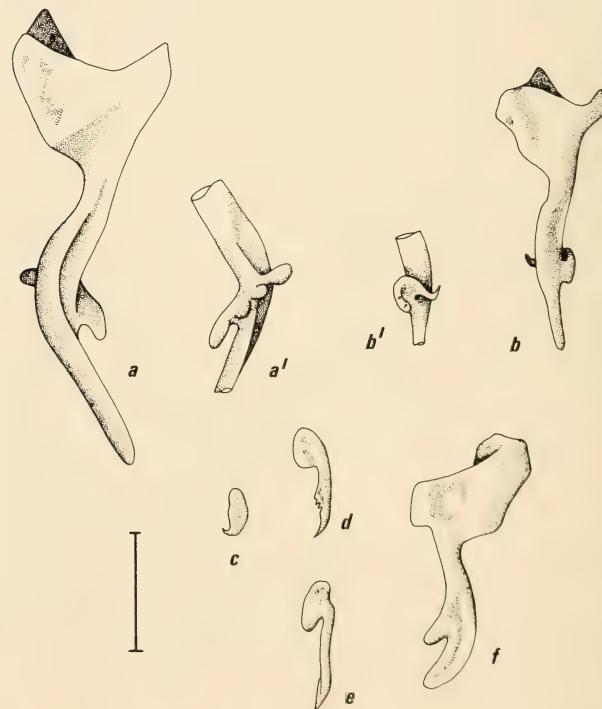


Fig. 25. Ventral view of accessory terminal 1 cartilage.
Scale 1,0 cm.

- a. *Cruriraja parcomaculata*; a¹. *C. parcomaculata* (dorsal view);
- b. *C. triangularis*; b¹. *C. triangularis* (dorsal view);
- c. *Rhinobatos annulatus*;
- d. *Anacanthobatis marmoratus*;
- e. *A. americanus*;
- f. *Cruriraja rugosa*.

The accessory terminal 1 in *Raja clavata*, *R. straeleni* and *R. miraletus* (Figs 24 e-g) is characterized by a single, outwardly directed proximal arm and a very well-developed and dorso-ventrally flattened distal blade. Although the form of the cartilage is somewhat similar in *Raja alba* (Fig. 24 h), it has not been included with *R. clavata* because of its elongate- rather than Z-shape, and because of the lack of a distinguishable proximal arm.

The U-shaped accessory terminal 1 in *Raja radiata* is unique (Fig. 24 i) and quite unlike the Y-form of the cartilage in *Raja confundens*, *R. leopardus*, *R. dissimilis*, *R. caudaspinosa* and *R. wallacei* (Figs 24 j-n), whose anterior limbs resemble that of *R. lanceorostrata*, and yet whose general form is quite different. The species specificity of the posterior extension should be noted.

(10) accessory terminal 2 cartilage

This cartilage, like the accessory terminal 1, arises at the distal end of the ventral marginal cartilage. It is situated on the median side of the accessory terminal 1. Although it may possess a median, lateral process, which can form the boss (*Cruriraja parcomaculata*, Fig. 27 a, a¹), it is the distal end which is



Fig. 26. Ventral view of accessory terminal 2 cartilage. Scale 2.0 cm.
 b. *Raja doutei*; c. *R. lanceorostrata*; d. *R. pullopunktata*; e. *R. clavata*; f. *R. straeleni*; g. *R. miraletus*; h. *R. alba*; i. *R. radiata*; j. *R. confundens*; k. *R. leopardus*; l. *R. dissimilis*; m. *R. caudaspinosa*; n. *R. wallacei*.

important and which forms the spike. An accessory terminal 2 cartilage is absent in *Rhinobatos annulatus*, *Myliobatis cervus* and *Bathyraja smithii*.

Groupings similar to those shown by the accessory terminal 1 cartilage can be seen. In the species *Raja doutrei*, *R. pullopectata* and *R. lanceorostrata* (Figs 26 b-d) the accessory terminal 2 projects distally as a simple rod, which may be hooked distally, and may or may not possess an attachment process. The cartilage is strongly united with the accessory terminal 1 in *Raja clavata* (Hulley 1966: fig. 3 E) and *R. straeleni*, while in *R. miraletus* the association does not appear to be that marked (Hulley 1969). Although not strongly united with the accessory terminal 1, the accessory terminal 2 cartilage in *Raja radiata* is somewhat curled (Fig. 26 i), so as to lie within the cavity of the accessory terminal 1 (Fig. 34). The accessory terminal 2 in *Raja alba* (Fig. 26 h) is simple, with a shortened distal end, so that a spike is not formed in the glans. It has a process on its inner lateral margin, which butts against the axial cartilage. The species *Raja dissimilis*, *R. caudaspinosa*, *R. confundens*, *R. leopardus* and *R. wallacei* possess a characteristically shaped accessory terminal 2 (Figs 26 j-n).

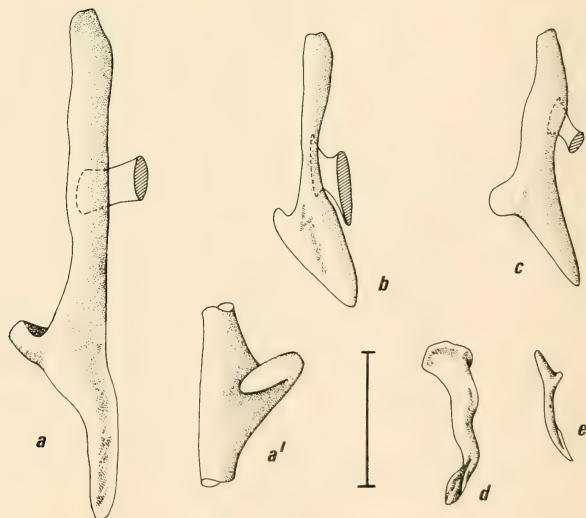


Fig. 27. Ventral view of accessory terminal 2 cartilage.
Scale 1,0 cm.

- a. *Cruriraja parcomaculata*; a'. *C. parcomaculata* (dorsal view);
- b. *C. triangularis*; c. *C. rugosa*; d. *Anacanthobatis marmoratus*;
- e. *A. americanus*.

In the genus *Cruriraja* (Figs 27 a-c), the cartilage is elongate, and in the three species examined a lateral process was found. Distally the cartilage is rounded.

A similarly shaped accessory terminal 2 cartilage is found in *Anacanthobatis marmoratus* (Fig. 27 d), except that there is no lateral process and the flattened,

distal region is curled to form a spoon-shaped end. In *Anacanthobatis americanus* (Fig. 27 e), the accessory terminal 2 is Y-shaped, and similar in appearance to the accessory terminal 1 cartilage in this species.

(ii) *accessory terminal 3 and 4 cartilages*

These cartilages are present only in *Raja clavata*, *R. straeleni* and *R. miraletus*, and form the signal of the clasper glans. As with other accessory terminal cartilages, they are attached at the distal end of the ventral marginal, more ventral than the attachment of the accessory terminal 1 and 2 cartilages. In *Raja miraletus* (Fig. 28 c) there is a single cartilaginous element, the accessory terminal 3, while in *R. clavata* and *R. straeleni* (Figs 28 a–b) two cartilages are present. In the latter two species, the accessory terminal 4 is movable on the accessory terminal 3.

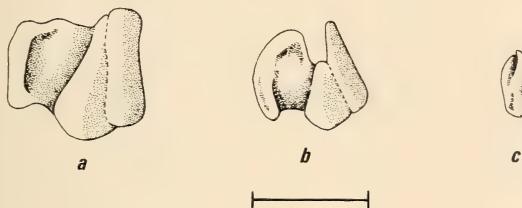


Fig. 28. Ventral view of accessory terminals 3 and 4.

Scale 2.0 cm.

a. *Raja clavata*; b. *R. straeleni*; c. *R. miraletus*.

VERTEBRAL COUNT

Vertebral numbers have been employed as taxonomic characters in teleosts (Bailey & Gosline 1955; Lagler *et al.* 1962). Their possible use in elasmobranch taxonomy was reviewed by Springer & Garrick (1964), while their species specificity in Japanese rajids has been investigated by Ishiyama (1952, 1958) and in European rajid species by Stehmann (1970). Vertebral counts for South African west and south coast Rajidae have been given by Hulley (1970). Krefft (1968a) has analysed the terminology, and has proposed a standard method for distinguishing the various groups of vertebrae.

In rajids, the vertebrae may be divided into two groups, trunk (Vtr) and predorsal caudal (Vprd) vertebrae, of which the latter appears to be more suitable for taxonomic purposes. The number of predorsal caudal vertebrae is not species specific (Ishiyama, 1958), although the count may, in some cases, be used to distinguish between closely related species (Hulley 1970; Stehmann 1970).

Interpreting the predorsal caudal count according to the method of Hubbs & Hubbs (1953), Ishiyama (1958) recognizes two forms of rajids, the 'northern' form (*Bathyraja* and *Rhinoraja*) with more than 61–62 Vprd, and the 'southern' form (*Raja*) with less than 61–62 Vprd. Stehmann (1970) can find no clear-cut distinction between the two genera, *Bathyraja* and *Raja*, in European species, but

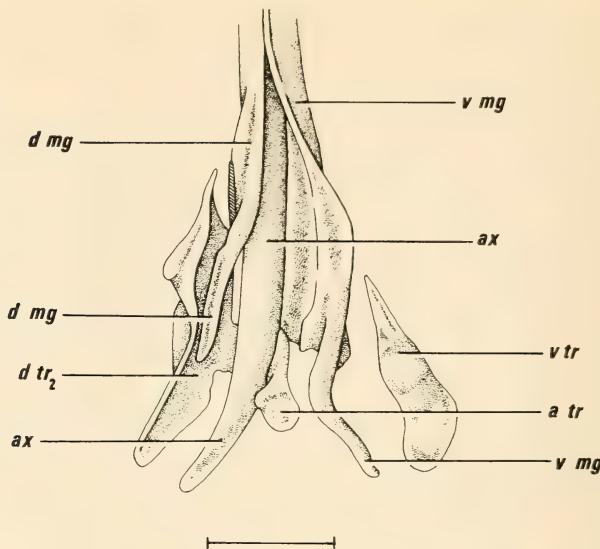


Fig. 29. *Bathyraja smithii*. Cartilages of right clasper (exploded) with $d.tr_1$ removed. Scale 2,0 cm.

a.tr.—accessory terminal; ax—axial; d.mg—dorsal marginal;
d.tr—dorsal terminal; v.mg.—ventral marginal; v.tr—ventral
terminal.

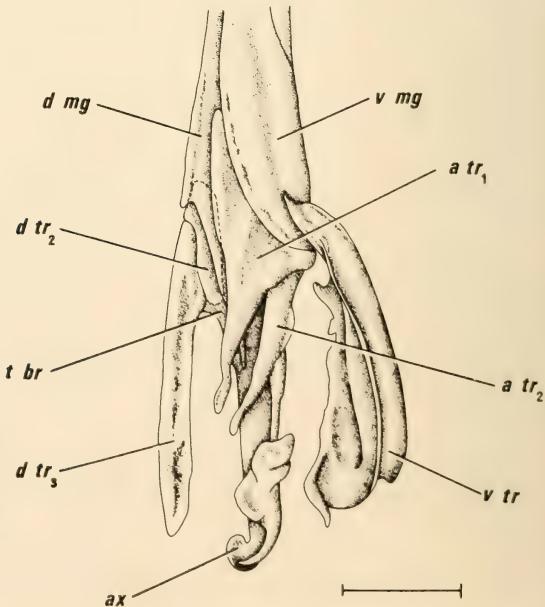


Fig. 30. *Raja doutrei*. Cartilages of right clasper (exploded) with $d.tr_1$ removed. Scale 2,0 cm.
a.tr—accessory terminal; ax—axial;
dm.g—dorsal marginal; d.tr—dorsal
terminal; t.br—terminal bridge;
v.mg—ventral marginal; v.tr—ven-
tral terminal.

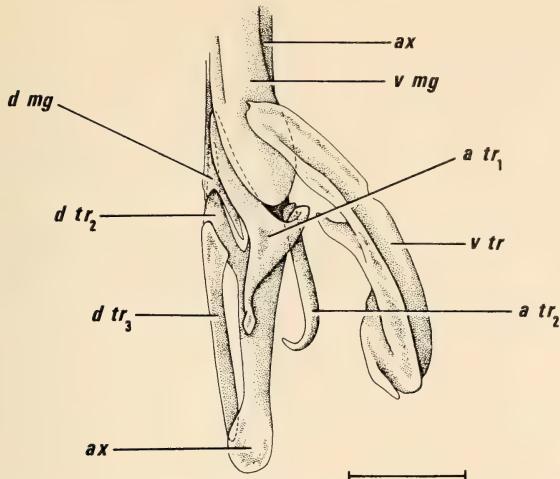


Fig. 31. *Raja lanceorostrata*. Cartilages of right clasper (exploded) with *d.tr₁* removed. Scale 2,0 cm.
a.tr—accessory terminal; *ax*—axial; *d.mg*—dorsal marginal;
d.tr—dorsal terminal; *v.mg*—ventral marginal; *v.tr*—ventral terminal.

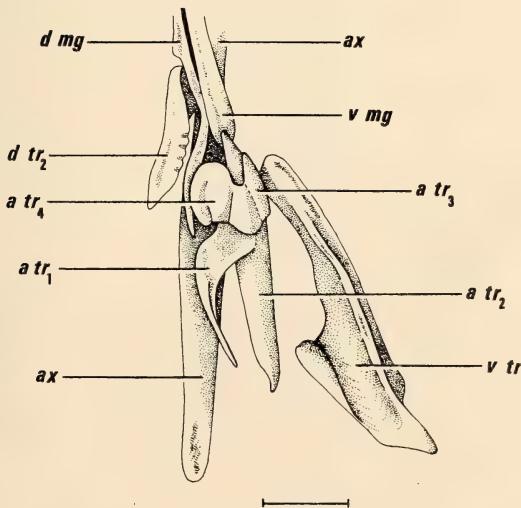


Fig. 32. *Raja straeleni*. Cartilages of right clasper (exploded) with *d.tr₁* removed. Scale 2,0 cm.
a.tr—accessory terminal; *ax*—axial; *d.mg*—dorsal marginal;
d.tr—dorsal terminal; *v.mg*—ventral marginal; *v.tr*—ventral terminal.

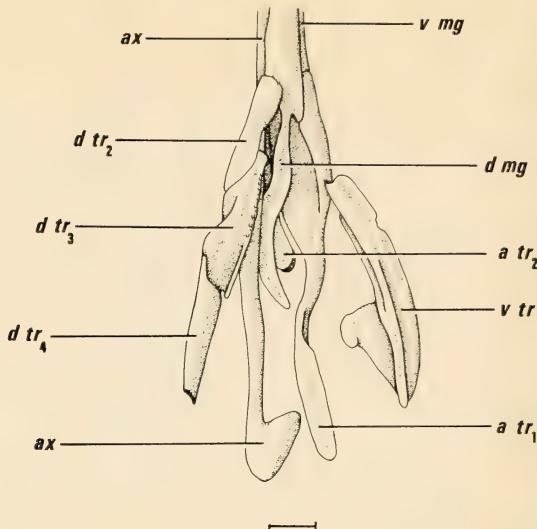


Fig. 33. *Raja alba*. Cartilages of right clasper (exploded) with *d.tr₁* removed. Scale 2,0 cm.
a.tr—accessory terminal; *ax*—axial; *d.mg*—dorsal marginal;
d.tr—dorsal terminal; *v.mg*—ventral marginal; *v.tr*—ventral terminal;

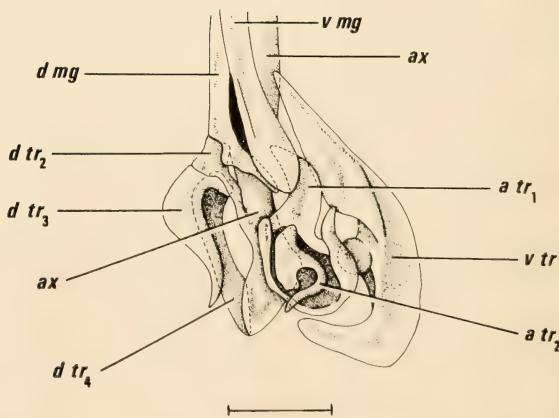


Fig. 34. *Raja radiata*. Cartilages of right clasper (exploded) with *d.tr₁* removed. Scale 2,0 cm.
a.tr—accessory terminal; *ax*—axial; *d.mg*—dorsal marginal;
d.tr—dorsal terminal; *v.mg*—ventral marginal; *v.tr*—ventral terminal.

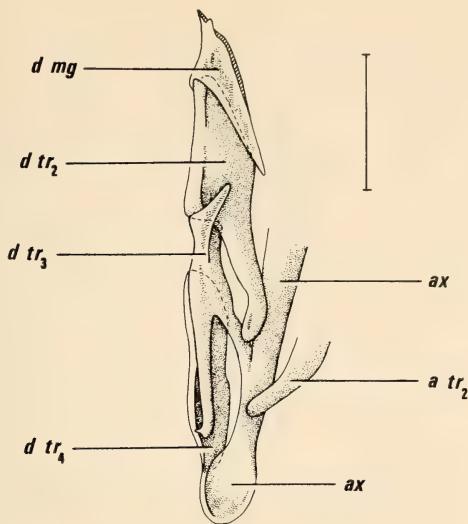


Fig. 35. *Raja wallacei*. Ventral view of cartilages of right clasper. Scale 2,0 cm.
 a.tr—accessory terminal; ax—axial; d.mg—dorsal marginal; d.tr—dorsal terminal.

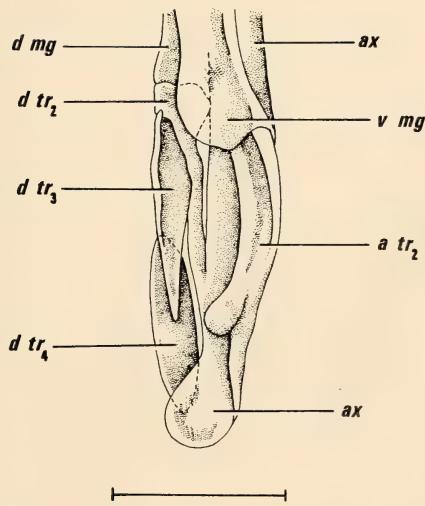


Fig. 36. *Raja confundens*. Ventral view of cartilages of right clasper, with d.tr₁, a.tr₁ and v.tr removed. Scale 2,0 cm.
 a.tr—accessory terminal; ax—axial; d.mg—dorsal marginal; d.tr—dorsal terminal; v.mg—ventral marginal.

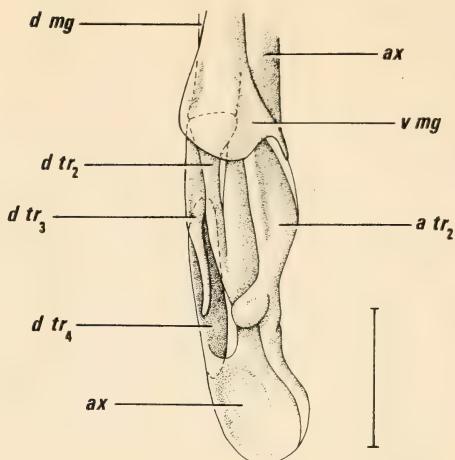


Fig. 37. *Raja leopardus*. Ventral view of cartilages of right clasper, with *d.tr₁*, *a.tr₁* and *v.tr* removed. Scale 2,0 cm.
a.tr—accessory terminal; *ax*—axial; *d.mg*—dorsal marginal; *d.tr*—dorsal terminal; *v.mg*—ventral marginal.

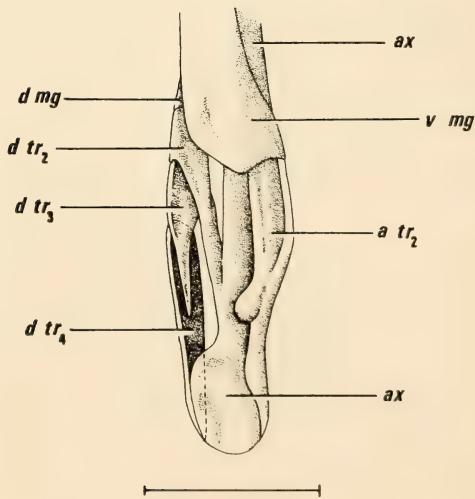


Fig. 38. *Raja dissimilis*. Ventral view of cartilages of right clasper, with *d.tr₁*, *a.tr₁* and *v.tr* removed. Scale 2,0 cm.
a.tr—accessory terminal; *ax*—axial; *d.mg*—dorsal marginal; *d.tr*—dorsal terminal; *v.mg*—ventral marginal.

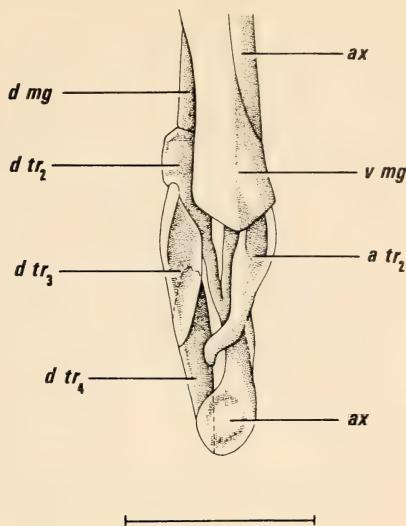


Fig. 39. *Raja caudaspinosa*. Ventral view of cartilages of right clasper, with d.tr₁, a.tr₁ and v.tr removed. Scale 2,0 cm.
 a.tr—accessory terminal; ax—axial; d.mg—dorsal marginal; d.tr—dorsal terminal; v.mg—ventral marginal.

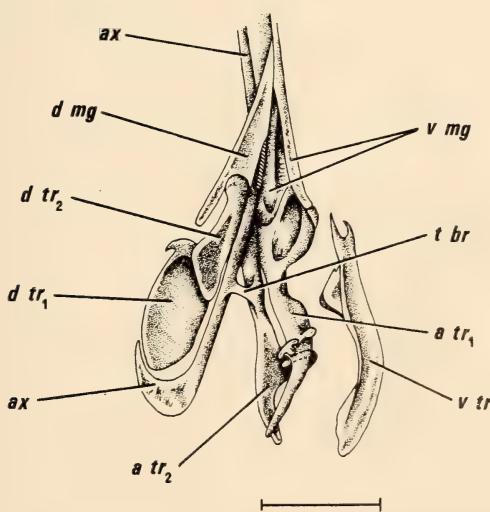


Fig. 40. *Cruriraja parcomaculata*. Cartilages of right clasper (exploded). Scale 2,0 cm.
 a.tr—accessory terminal; ax—axial; d.mg—dorsal marginal; d.tr—dorsal terminal; t.br—terminal bridge; v.mg—ventral marginal; v.tr—ventral terminal

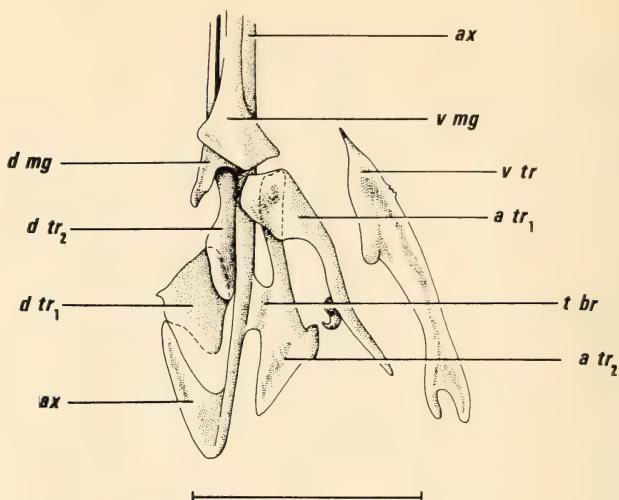


Fig. 41. *Cruriraja triangularis*. Cartilages of right clasper (exploded). Scale 2,0 cm.
 a.tr—accessory terminal; ax—axial; d.mg—dorsal marginal;
 d.tr—dorsal terminal; t.br—terminal bridge; v.mg—ventral marginal;
 v.tr—ventral terminal.

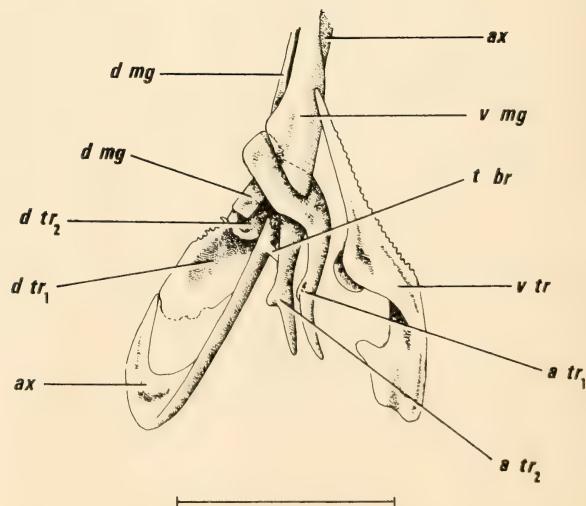


Fig. 42. *Cruriraja rugosa*. Cartilages of right clasper (exploded). Scale 2,0 cm.
 a.tr—accessory terminal; ax—axial; d.mg—dorsal marginal;
 d.tr—dorsal terminal; t.br—terminal bridge; v.mg—ventral marginal;
 v.tr—ventral terminal.

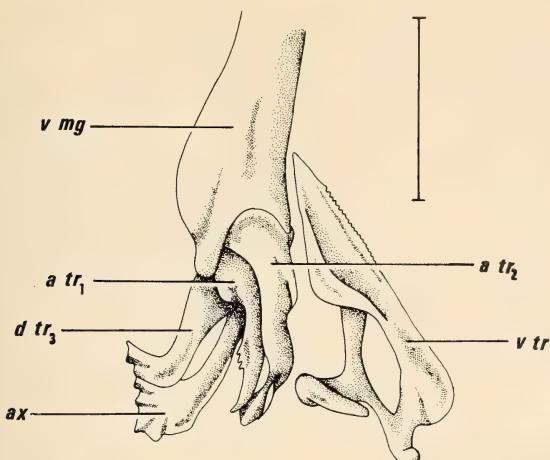


Fig. 43. *Anacanthobatis marmoratus*. Cartilages of right clasper (exploded) with d.tr₁ removed. Scale 1,0 cm.
 a.tr—accessory terminal; ax—axial; d.mg—dorsal marginal;
 d.tr—dorsal terminal; v.mg—ventral marginal; v.tr—ventral terminal.

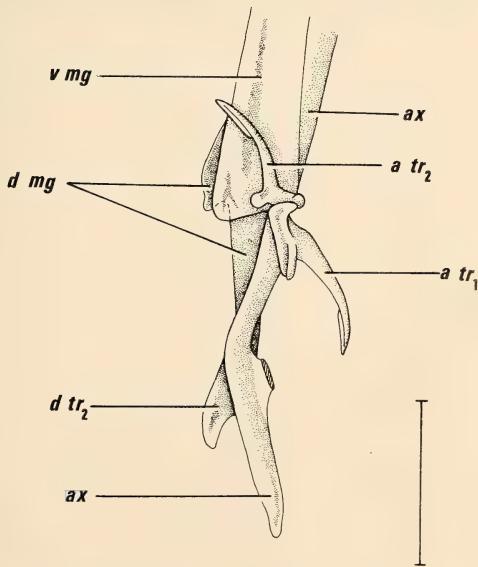


Fig. 44. *Anacanthobatis americanus*. Ventral view of cartilages of right clasper with d.tr₁ removed.
 Scale 1,0 cm.
 a.tr—accessory terminal; ax—axial; d.mg—dorsal marginal;
 d.tr—dorsal terminal; v.mg—ventral marginal.

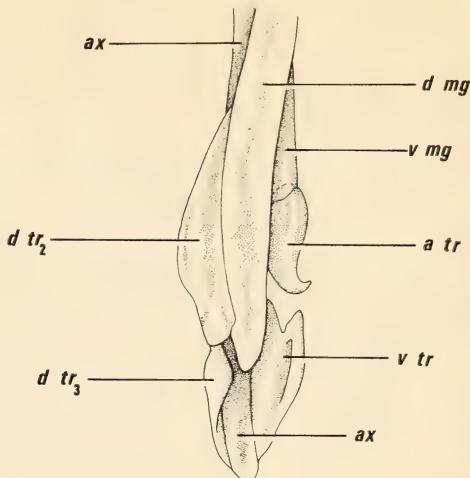


Fig. 45. *Rhinobatos annulatus*. Dorsal view of cartilages of right clasper, with *d.tr₁* removed. Scale 0,5 cm.
a.tr—accessory terminal; *ax*—axial; *d.mg*—dorsal marginal; *d.tr*—dorsal terminal; *v.mg*—ventral marginal; *v.tr*—ventral terminal.

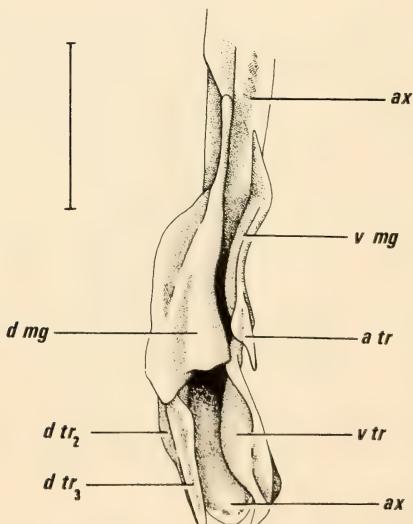


Fig. 46. *Myliobatis cervus*. Lateral view of cartilages of right clasper with *d.tr₁* removed. Scale 2,0 cm.
a.tr—accessory terminal; *ax*—axial; *d.mg*—dorsal marginal; *d.tr*—dorsal terminal; *v.mg*—ventral marginal; *v.tr*—ventral terminal.

divides them into four groups. The group limits appear to be arbitrary and are exceeded by some of the species (Stehmann 1970: fig. 14), so that this clustering is artificial and bears no resemblance to the groupings suggested by clasper structure and cranial anatomy. The picture is further complicated by the fact that, as in teleosts (Tester 1938; Tåning 1950; Post 1968), there appears to be some correlation between water temperature and vertebral number in skates (Ishiyama 1958). However, Stehmann (1970) states that an intra-specific dependence of the number of predorsal caudal vertebrae on water temperature is not noticeable in eastern North Atlantic species. In the case presented, i.e. *Raja miraletus*, it may be that we are dealing here with isothermic distribution rather than temperature differences based on geographic distribution.

Predorsal caudal vertebral counts can be used in the interpretation of the phylogeny of rajids. Ishiyama (1958: 237) has pointed out that 'the variation in vertebral count in each group of species (as ascertained from clasper structure) can be considered corresponding with phylogenetic progression along each branch' and has shown that with evolution there is a trend in reduction in number of predorsal caudal vertebrae. It is within this context that the predorsal caudal count of southern African rajids will be discussed.

TABLE I

Predorsal caudal vertebral counts (Vprd) for southern African Rajidae.

Species	No. of specimens	Range	Mean
<i>B. smithii</i>	6	68-71	69,2
<i>R. straeleni</i>	4	48-52	49,3
<i>R. clavata</i>	10	45-53	47,7
<i>R. miraletus</i>	17	44-52	48,5
<i>R. alba</i>	6	62-67	64,0
<i>R. pullo punctata</i>	14	50-58	53,4
<i>R. dottrei</i>	4	43-49	46,0
<i>R. springeri</i>	3	53-56	55,0
<i>R. stenorhynchus</i>	1	—	49,0
<i>R. lanceorostrata</i>	2	56-57	56,5
<i>R. robertsi</i>	1	—	55,0
<i>R. radiata</i>	2	58-62	60,0
<i>R. wallacei</i>	10	64-74	69,0
<i>R. ravidula</i>	3	69-70	69,3
<i>R. dissimilis</i>	3	65-69	67,0
<i>R. caudaspinosa</i>	15	66-73	67,0
<i>R. leopardus</i>	7	55-58	56,9
<i>R. confundens</i>	5	55-63	59,2
<i>R. spinacidermis</i>	3	60-65	62,7
<i>G. parcomaculata</i>	6	66-69	67,8
<i>G. triangularis</i>	4	65-70	67,3

The predorsal caudal vertebral count for southern African species is given in Table I, and is represented graphically in Figure 47, in subgeneric groupings. Vprd counts for *Raja miraletus* and *R. straeleni* given by Krefft (1968a) are incorporated in the results.

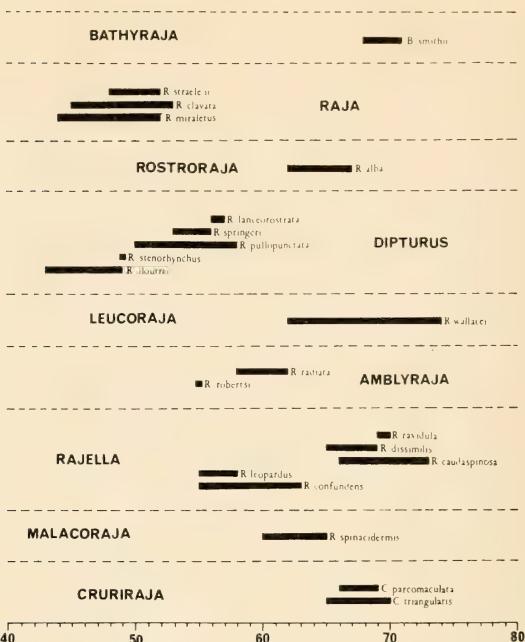


Fig. 47. Ranges in number of predorsal caudal vertebrae (Vprd) in southern African Rajidae.

NEUROCRANUM AND ROSTRAL CARTILAGES

In order to establish the phylogenetic positions of suborders within the Batoidei, comparative anatomical studies on various neurocrania have been made (Gegenbaur 1872; Parker 1879; Garman 1913; Holmgren & Stensio 1936; Davies 1948; Melouk 1949; El-Tourbi & Hamdy 1959; Gohar & Bayoumi 1959; Hamdy 1964) and these have been supplemented by developmental studies (Parker 1879; De Beer 1926, 1932, 1937; Holmgren 1940, 1941; Hamdy 1956).

From a taxonomic viewpoint at the generic level, Bigelow & Schroeder (1948) studied the X-ray structure of *Psammobatis*, *Sympterygia* and some *Raja* species, with particular reference to the rostral projection and the degree of forward extension of the anterior radials of the pectoral fins. This resulted in the distinction of a new genus *Breviraja*. Following on this, Ishiyama (1952, 1958, 1968) recognized this genus in Japanese rajids and was able to show that a further new genus, *Rhinoraja*, could be established on rostral characters.

Subsequently, Ishiyama & Hubbs (1968) pointed out that the Pacific brevirajid species were distinct from the Atlantic species, not only in terms of clasper structure, but also in the shape and size of the rostral cartilage and rostral appendices. They therefore defined a new genus, *Bathyraja*, confining it solely to the Pacific region. However, this genus has now been recognized in the

North Atlantic (Stehmann 1970) and in the southern African region (Hulley 1970).

Further differences in the anatomy of the neurocrania of Japanese rajids were found by Ishiyama (1958), who showed a certain degree of species specificity in the shape and extension of the anterior and posterior fontanelles. However, Heintz (1962) found that the cartilaginous neurocranium could be modified by external factors, and noted differences only in the anterior fontanelle, orbital and otic regions of the neurocrania of *Raja batis*, *R. nidorosiensis* and *R. oxyrhynchus*, so that on the basis of structure alone it was impossible to draw any conclusions of the relationship of the three species.

On the other hand, Stehmann (1970) found that while species specificity may not necessarily be evident from cranial structure, there appeared to be certain parts, which could be used as auxiliary characters in the grouping of the species within the proposed subgenera. These included:

1. The shape and orientation of the nasal capsules with regard to the median axis of the skull.
2. The appearance and size of the *processus praeorbitalis*, including the *crista praeorbitalis*.
3. The form of the *regio orbito-temporalis*.
4. The size and position of the jugal arches.
5. The form and position of the anterior and posterior fontanelles.

Differences in cranial morphometry for taxonomic use were suggested by Ishiyama (1958) and some 18 measurements have now been proposed as standards (Hubbs & Ishiyama 1968). However, both Heintz (1962) and Stehmann (1970) find that these possess no species specificity, although Stehmann (1970) finds that the length of the rostrum in comparison with the length of the cranium can be used for grouping the species. The course of the hypothetical line, drawn from the tip of the rostrum and over the *Foramen ophthalmicus profundus V* to the otic region (Stehmann 1970) is obviously some complex function of the rostral length/cranial width, and is difficult to interpret as a single character.

Description

Descriptions are based mainly on neurocrania which have been prepared. However, in cases where this was not possible, some results, such as general shape, orientation of the nasal capsules, form of the anterior and posterior fontanelles and size of the jugal arches, have been obtained from X-ray photographs. Details of the cranial anatomy of *Rhinobatos halavi* have been given by El-Tourbi & Hamdy (1959) and are used in this description.

The neurocranium is a violin-shaped structure, which is dorso-ventrally compressed and is constricted at the orbital region. The nasal capsules are fused to this anteriorly and the auditory capsules posteriorly. The rostral bar projects from the mid-region as a hard bar, to which are attached the rostral appendices.

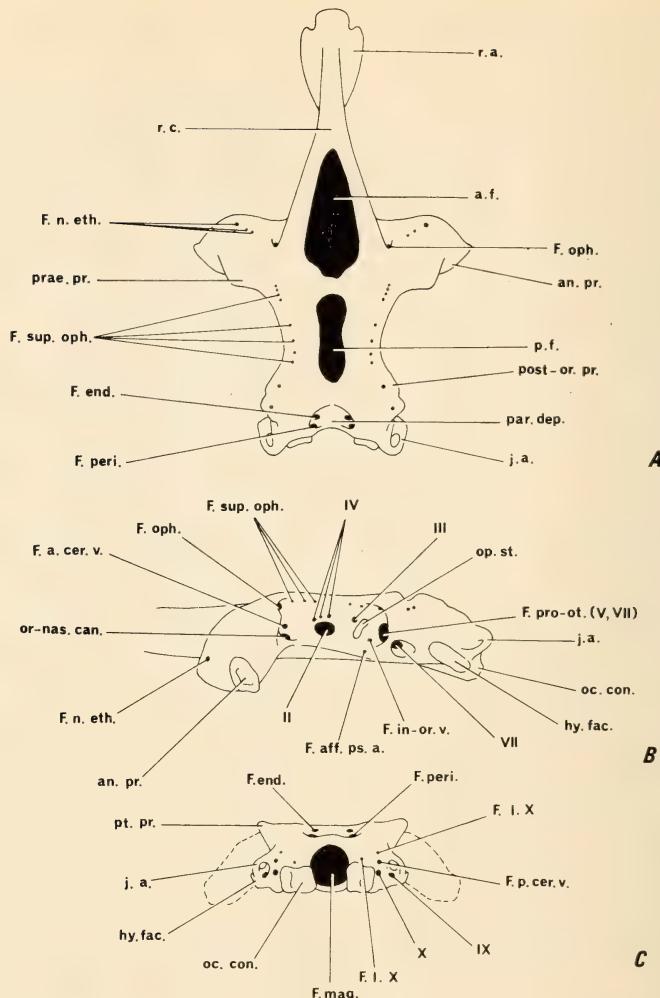


Fig. 48. Neurocranium of a typical rajid showing positions of foramina and fontanelles.

a.f.—anterior fontanelle; an.pr.—antorbital process; F.a.cer.v.—anterior cerebral vein foramen; F.aff.ps.a.—afferent pseudobranchial artery foramen; F.end.—endolymphatic foramen; F.in-or.v.—interorbital vein foramen; F.l. X—foramen of lateralis branch (X); F.mag.—foramen magnum; F.n.eth.—ethmoidal nerve foramen; F.oph—ophthalmic foramen; F.p.cer.v.—posterior cerebral vein foramen; F.peri.—perilymphatic foramen; F.pro-ot.—prootic foramen; F.sup.oph.—superficial ophthalmic foramen; hy.fac.—hyomandibular facet; j.a.—jugal arch; oc.con.—occipital condyle; or-nas.can.—oro-nasal canal; op.st.—optic stalk; p.f.—posterior fontanelle; par.dep.—parietal depression; prae.pr.—praeorbital process; post-or.pr.—postorbital process; pt.pr.—pterotic process; r.a.—rostral appendix; r.c.—rostral cartilage; II—optic nerve foramen; III—oculomotor nerve foramen; IV—pathetic (trochlear) nerve foramen; VII—foramen of hyomandibular branch (VII); IX—glossopharyngeal nerve foramen; X—vagus nerve foramen.

The nature of the bar and appendices have been described by Hulley (1970), while the varying lengths of the rostra in relation to cranial length are given in Table 2.

TABLE 2

Rostral length expressed as a percentage of the cranial length
in southern African Rajidae.

Species	No. of specimens	Mean %
<i>C. parcomaculata</i>	3	39,6
<i>C. triangularis</i>	2	47,6
<i>R. doutei</i>	2	63,5
<i>R. pullopectata</i>	5	56,7
<i>R. lanceostrata</i>	1	65,7
<i>R. springeri</i>	2	65,3
<i>R. stenorhynchus</i>	1	70,7
<i>R. miraleetus</i>	5	45,6
<i>R. clavata</i>	10	48,1
<i>R. straeleni</i>	2	49,0
<i>R. alba</i>	4	57,0
<i>R. radiata</i>	2	46,2
<i>R. robertsi</i>	1	46,5
<i>R. wallacei</i>	2	45,4
<i>R. caudaspinosa</i>	6	37,6
<i>R. leopardus</i>	10	49,6
<i>R. confundens</i>	3	50,1
<i>R. dissimilis</i>	3	46,4
<i>R. ravidula</i>	3	52,4
<i>R. spinacidermis</i>	1	41,3
<i>B. smithii</i>	3	45,5

The course of the hypothetical line drawn from the tip of the rostrum and through the ophthalmic foramen to the occipital region, cuts the otic region in *Raja alba*, *R. leopardus* and *Cruriraja parcomaculata*, runs at a tangent to the otic region in *Raja doutei* and *R. confundens*, and passes the otic region without touching in *Bathyraja smithii*, *Raja pullopectata*, *R. clavata*, *R. miraleetus*, *R. radiata* and *R. caudaspinosa*.

The nasal capsules are relatively thin-walled structures, which are attached to the side walls of the brain case. They are orientated to form a right angle with the median axis of the cranium in *Rhinobatos halavi* (El-Tourbi & Hamdy 1959: pl. 1), *Bathyraja smithii*, *Raja clavata*, *R. straeleni*, *R. caudaspinosa*, *R. confundens* and *Cruriraja parcomaculata* (Figs 49 A, E; 51 A, D; 53 A, E). The angle is slightly acute in *Raja stenorhynchus*, *R. springeri*, *R. lanceostrata*, *R. doutei*, *R. pullopectata*, *R. miraleetus*, *R. radiata*, *R. robertsi*, *R. dissimilis*, *R. ravidula* and *R. leopardus* (Figs 50 A, D, E, F, G; 51 E; 52 D, E; 53 D; 54 A, D), more so in *R. wallacei* (Fig. 54 F), and extremely acute in *R. alba* and *R. spinacidermis* (Figs 52 A; 54 E). In *Raja spinacidermis*, *R. ravidula*, *R. dissimilis* and *R. robertsi* (Figs 52 D; 53 D; 54 D, E), the nasal capsules are comparatively larger than in the other species. There is a well-developed articular process for the attachment of the antorbital process at the latero-posterior edge of each nasal capsule, while antero-dorsally there is usually one small foramen (sometimes more, e.g. *Raja clavata* (Fig. 51 A))

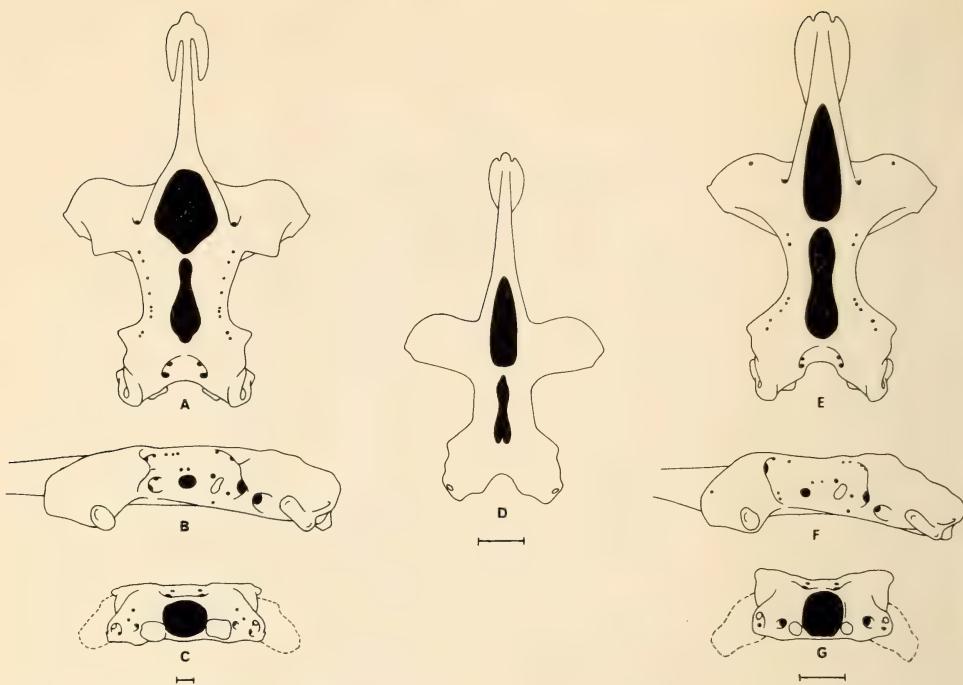


Fig. 49. Dorsal, lateral and posterior views of the neurocrania of:
A. B. C. *Bathyraja smithii*; D. *Cruriraja triangularis* (X-ray reconstruction); E. F. G. *C. parcomaculata*.

for the passage of the ethmoidal nerve, a small, lateral branch of the superficial ophthalmic nerve. The foramen appears to be absent in *Bathyraja smithii*, *Raja leopardus* and *R. confundens* (Figs 49 A; 53 A; 54 A). However, the close proximity of this foramen to the ophthalmic foramen in *Raja caudaspinosa* (Fig. 53 E) suggests that the ethmoidal nerve and the superficial ophthalmic nerve may have a common foramen in these species.

The *crista supraorbitalis* is continued anteriorly to expand on the postero-dorsal region of the nasal capsule, where it develops to form the preorbital process (*crista praeorbitalis* of Heintz (1962); preorbital cartilage of Holmgren (1940)). The preorbital process is best developed in *Rhinobatos halavi* (El-Tourbi & Hamdy 1959: pl. I A), *Bathyraja smithii*, *Raja clavata*, *R. miraletus* and *R. alba* (Figs 49 A; 51 A, E; 52 A), not so marked in *Raja doutrei*, *R. pullo punctata*, *R. radiata*, *R. leopardus*, *R. confundens* and *R. caudaspinosa* (Figs 50 A, G; 52 E; 53 A, E; 54 A), and least developed in *Cruriraja parcomaculata* (Fig. 49 E).

The *crista supraorbitalis*, which forms the dorsal border of the orbit, is perforated by a series of small foramina for the superficial ophthalmic nerves. The number of foramina varies in specimens of the same species and may even vary on opposite sides of the same specimen. The orbital region is characterized by the anterior position of the optic foramen, which is typical of the Rhinobatidae (El-Tourbi & Hamdy 1959) as well as of rajids (Figs 49–54). The optic

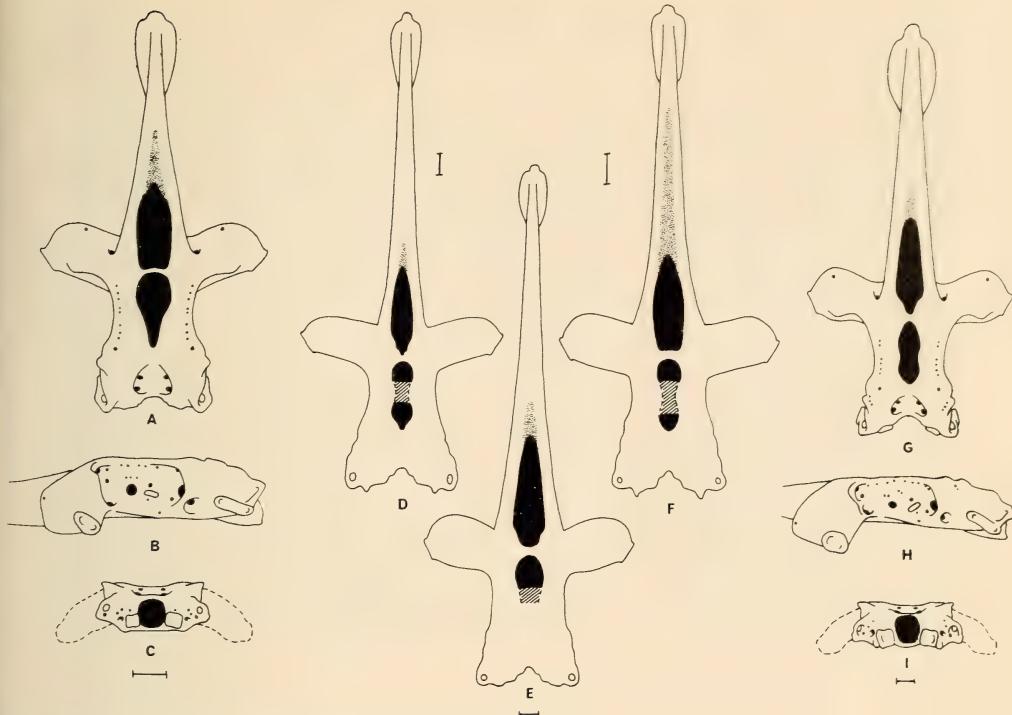


Fig. 50. Dorsal, lateral and posterior views of the neurocrane of:
A. B. C. *Raja pullo punctata*; D. *R. lanceostrata* (X-ray reconstruction); E. *R. stenorhynchus* (X-ray reconstruction);
F. *R. springeri* (X-ray reconstruction); G. H. I. *R. doutrei*.

foramen appears to be somewhat more anteriorly positioned in *Raja radiata*, *R. confundens*, *R. leopardus* and *R. caudaspinosa* (Figs 52 F; 53 B, F; 54 B) than it is in the other species. Above the optic foramen are a series of two or three small foramina for the passage of the pathetic (trochlear) nerve, the most anterior of which is the largest. Although these branches of the pathetic all innervate the superior oblique muscle, the single, large foramen, typical of *Rhinobatos* (Daniel 1934; El-Tourbi & Hamdy 1959) has not been found in rajids. The position of the pathetic foramen given by Heintz (1962) is erroneous and has obviously been confused with the foramen for the anterior cerebral vein.

In the antero-ventral region of the orbit is the large orbito-nasal canal foramen, which runs into the nasal capsule and accommodates the anterior facial vein (Holmgren 1940; El-Tourbi & Hamdy 1959). In *Cruriraja parcomaculata* (Fig. 49 F), the orbito-nasal canal is much narrower. Hyman (1942) points out that in the skate, the deep ophthalmic nerve leaves the orbit via the orbito-nasal canal, but dissection of several species has revealed that this nerve joins the superficial ophthalmic nerve at the antero-dorsal region of the orbit, the two nerves passing through a single foramen, the ophthalmic foramen. This is also found in *Rhinobatos halavi*, *Rhynchobatos djiddensis* and *Trygon kuhlii*.

(El-Tourbi & Hamdy 1959) and would therefore appear to be a constant feature in batoids.

Between the ophthalmic foramen and the foramen for the orbito-nasal canal is a small foramen for the passage of the anterior cerebral vein. In *Bathyraja smithii*, *Raja miraletus* and *R. clavata* (Figs 49 B; 51 B, F), it is situated at about the same level as the optic foramen, in *Raja alba* (Fig. 52 B) it is displaced ventrally, and in *Raja doutei*, *R. pullopectata*, *R. radiata*, *R. confundens*, *R. leopardus* and *R. caudaspinosa* (Figs 50 B, H; 52 F; 53 B, F; 54 B) it is displaced dorsally.

Posterior to, and at about the same level as, the optic foramen is the cartilaginous optic stalk, above which is a single foramen for the oculomotor (III) nerve. The most conspicuous foramen in the orbit is the large pro-otic foramen, which is separated from the smaller foramen of the hyomandibular branch (VII) by the prefacial commissure. Positioned anteriorly to the prefacial commissure and almost at the ventral edge of the orbit is a very small foramen for the afferent pseudobranchial artery. Between this and the pro-otic foramen is another small aperture for the interorbital vein (pituitary vein of El-Tourbi & Hamdy (1959)), which runs into the cranial cavity in the *sella turcica*, placing the two orbits in communication with one another. This has been incorrectly termed the abducent foramen by Heintz (1962), although it has been labelled as IV (trochlear) in the figure (fig. 2 B). Dissection has revealed that, as in the

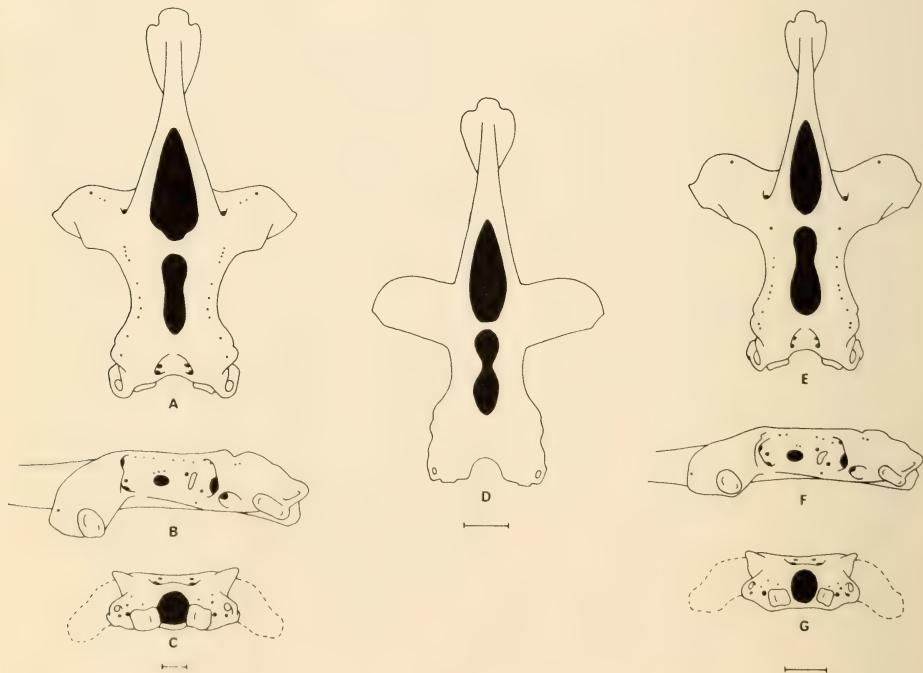


Fig. 51. Dorsal, lateral and posterior views of the neurocrania of:
A. B. C. *Raja clavata*; D. *R. straeleni* (X-ray reconstruction); E. F. G. *R. miraletus*.

case of *Rhinobatos halavi*, *Rhynchoselachus djiddensis* and *Trygon kuhlii* (El-Tourbi & Hamdy 1959), the abducent nerve enters the orbit through the pro-otic foramen in rajids.

The posterior border of the orbital region is marked dorsally by the small postorbital process. It is most prominent in *Bathyraja smithii* (Fig. 49 A). On each side of the neurocranium, at its posterior end, are the auditory capsules, between which is the parietal depression (endolymphatic fossa of El-Tourbi & Hamdy (1959)). This is similarly situated in all rajid species and contains two pairs of foramina leading to the auditory capsules. The anterior pair are the endolymphatic foramina and the posterior pair, which lead directly to the perilymphatic cavity, are the perilymphatic foramina.

At the posterior edge of the lateral surface of the auditory capsule is the articular facet of the hyomandibular cartilage, which is in the form of an elongate, slightly concave groove, running antero-dorsally. It is bordered dorsally by a shallow depression, the postorbital groove, which contains the posterior region of the postorbital sinus. This vessel passes through the jugal arch to become the anterior cardinal vein (jugular vein of Heintz (1962)) at the junction with the posterior cerebral vein (O'Donoghue & Abbott 1928). The jugal arch links the protuberance of the hyomandibular facet to the posterior region of the auditory capsule. Its size and position (Figs 49–54) seem to bear

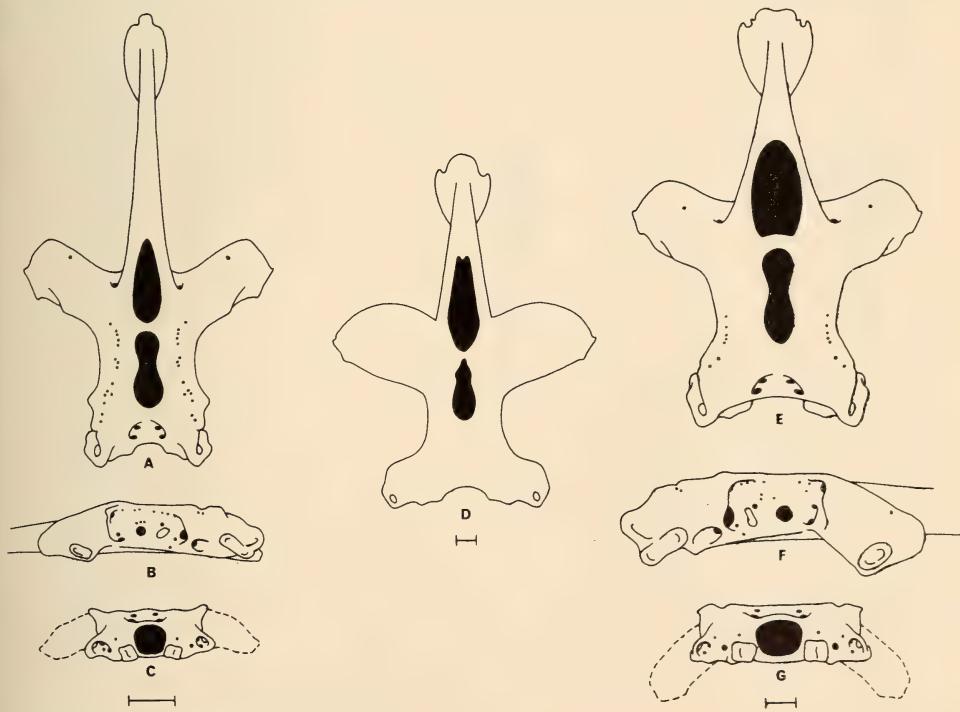


Fig. 52. Dorsal, lateral and posterior views of the neurocrania of:
A. B. C. *Raja alba*; D. *R. robertsi* (X-ray reconstruction); E. F. G. *R. radiata*.

some relationship to the groupings suggested by the clasper structure.

The occipital region of the neurocranium is more or less similar in form in all species (Figs 49–54), although the skull appears to be comparatively higher and narrower in *Raja confundens* and *R. caudaspinosa* (Figs 53 C, G). Foramina for the posterior cerebral vein are absent in *Cruriraja parcomaculata* (Fig. 49 G), so that in this species the vein probably leaves the cranial cavity together with the vagus nerve (X), as in the case of *Squalus acanthias* (O'Donoghue & Abbott 1928).

The ventral surface of the neurocranium runs forwards from the occipital region as a flat plate, although it forms a shallow subethmoidal depression between the bases of the nasal capsules. Medially, it is perforated by one (sometimes two) small foramen, through which the internal carotid artery enters the cranial cavity. Hyrtl (1872) has described the cross-over system of the internal carotids in *Raja clavata*. Anterior to the subethmoidal depression, the prolongation of the trabecular plates leads to the formation of the rostral cartilage (El-Tourbi & Hamdy 1959), which runs in an even curve towards the tip of the snout. As has been pointed out (Hulley 1970: fig. 20), some lateral undulation of the rostral cartilage occurs in *Bathyraja smithii*, but dorsal/ventral undulation of the rostral cartilage, especially at its anterior extremity, is found

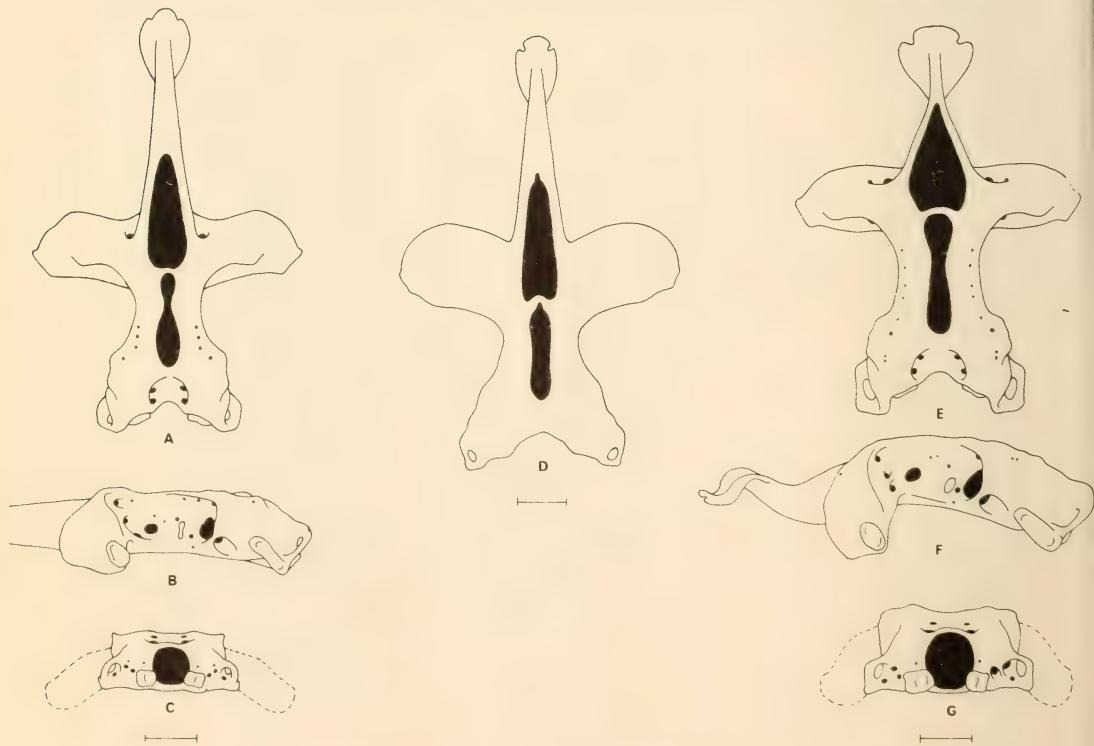


Fig. 53. Dorsal, lateral and posterior views of the neurocrania of:
A. B. C. *Raja confundens*; D. *R. dissimilis* (X-ray reconstruction); E. F. G. *R. caudaspinosa*.

only in *Raja caudaspinosa* (Fig. 53 F).

The dorsal surface of the neurocranium is perforated by two large fontanelles, separated by the narrow epiphysial bridge. The most anterior of these, usually termed the anterior fontanelle, is an amalgamation of the precerebral fontanelle and the anterior supracranial fontanelle (Hamdy 1960). The posterior fontanelle should therefore be correctly termed the posterior supracranial fontanelle (El-Tourbi & Hamdy 1959; Hamdy 1960). In *Rhinobatos halavi* and *Rhinobatos productus* (Daniel 1934: fig. 62), the anterior fontanelle is moderately wide at its posterior end, and narrows anteriorly to run as a groove, almost to the tip of the rostral cartilage, i.e. there is no marked anterior border to the fontanelle in these species. Anterior grooving of the rostral cartilage is found only in *Raja doutrei*, *R. pullospunctata*, *R. lanceorostrata* and *R. stenorhynchus* (Fig. 50) and reaches its maximum development in *R. springeri* (Fig. 50 F). In these species the posterior region of the anterior fontanelle is moderately wide, while the posterior margin is produced in *Raja doutrei* and *R. lanceorostrata* (Figs 50 D, G), and evenly curved in *Raja pullospunctata*, *R. stenorhynchus* and *R. springeri* (Figs 50 A, E, F). In *Bathyraja smithii* (Fig. 49 A) the anterior fontanelle is pear-shaped, with a broad posterior region and an evenly curved anterior margin, which is not elongated to form a furrow. In *Raja clavata*,

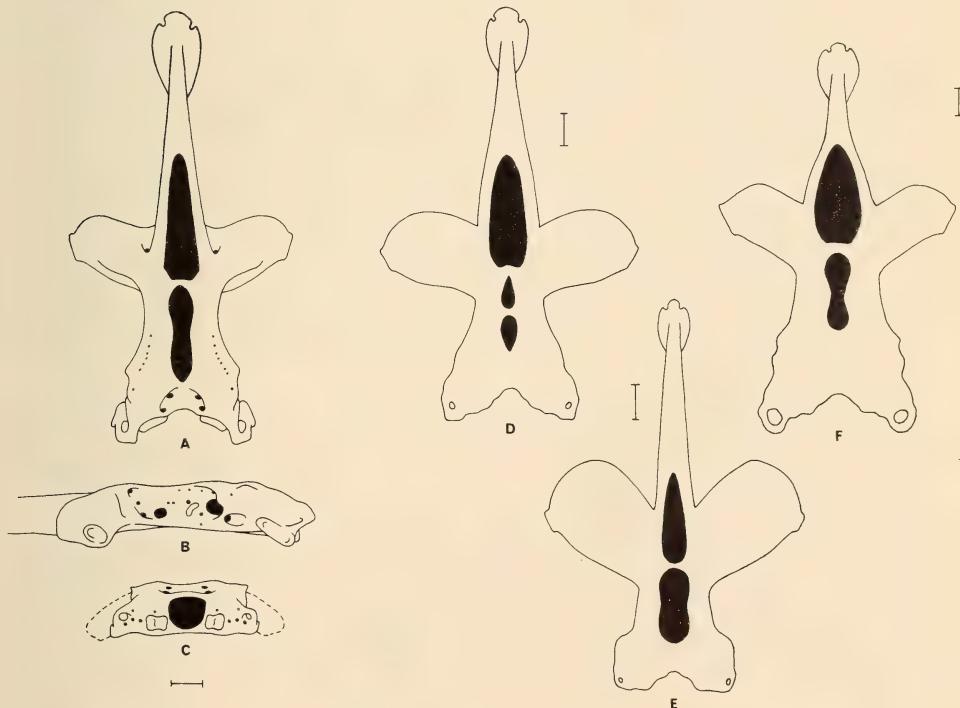


Fig. 54. Dorsal, lateral and posterior views of the neurocrania of:

A. B. C. *Raja leopardus*; D. *R. ravidula* (X-ray reconstruction); E. *R. spinacidermis* (X-ray reconstruction); F. *R. wallacei* (X-ray reconstruction).

R. straeleni, *R. miraletus*, *R. alba* and *R. wallacei* (Figs 51 A, D, E; 52 A; 54 F) the fontanelle is moderately obovate, while in *Raja dissimilis*, *R. ravidula*, *R. confundens* and *R. leopardus* (Figs 53 A, D; 54 A, D) it is narrowly obovate, with a convex posterior margin. In *Raja radiata* (Fig. 52 E) it is broadly obovate, and in *R. robertsi* (Fig. 52 D) ellipsoid with a truncate anterior margin. The fontanelle in *Raja spinacidermis* (Fig. 54 E) is reduced and extends only for about one-third the length of the rostral cartilage, but in *Raja caudaspinosa*, and *Cruriraja parcomaculata* (Figs 49 E; 53 E) it is broadly obovate and reaches the level of the rostral appendices. *Cruriraja triangularis* (Fig. 49 D) differs from *C. parcomaculata* in that the anterior fontanelle does not reach the level of the rostral appendices.

The posterior fontanelle is difficult to follow, especially in X-ray photographs, but it appears to be more or less similar in all species, being constricted to form a waist medially. This does not appear to be the case in *Raja pullospunctata* and *R. dissimilis* (Figs 50 A; 53 D), while in *R. ravidula* (Fig. 54 D) two posterior fontanelles are present. The extent of the posterior fontanelles, their anterior and posterior margins, and the degree of constriction vary in the different species (Figs 49–54).

DISCUSSION

It is recognized (Bigelow & Schroeder 1962) that the suborder Rajoidea may be divided into four families, Rajidae, Arhynchobatidae, Pseudorajidae and Anacanthobatidae, on the basis of the number of dorsal fins and the nature of the anterior lobe of the pelvic fin. De Buen (1959) recognized a further family Gurgesiellidae, based on a single specimen (*Gurgesiella furvescens*) from the abyssal region off Valparaiso, Chile. However, Bigelow & Schroeder (1962) hold that the characters on which the family were based appear to fall within the Pseudorajidae and have synonymized the two. It is now apparent that, not only is the family Gurgesiellidae valid, but also that *Pseudoraja atlantica*, known from the Atlantic coast of Nicaragua, falls within this family (Hulley 1972). It appears that the Rajidae possess common, but distinguishable characters in the structure of the pelvic bar and in the number of proximal basal segments in the myxopterygia.

As has been pointed out, two intermediate segments connect the basipterygium with the axial cartilage in *Raja*, *Cruriraja*, *Bathyraja* and *Anacanthobatis*. This would support the view that the number of basal segments varies within large groups of elasmobranchs (Huber 1901), and cannot be used for the separation of families within the Rajoidea. In terms of the pelvic girdle, the basic plan of a transverse (or only slightly arched) pelvic bar, with a pair of lateral prepelvic processes, is adhered to in the Rajoidea. However, the girdles can be divided into four (six, with the inclusion of the Pseudorajidae and Gurgesiellidae) distinctive groups.

Group I

Pelvic bar simply transverse; lateral prepelvic processes of varying length; iliac processes recurved; two or more obturatorial foramina.

The prepelvic processes appear to vary considerably in length between closely related species, e.g. *Raja clavata* and *R. straeleni* (Figs 3 g, j), so that this does not appear to be a suitable diagnostic character within the group. On the basis of anterior arching of the bar, the black-bellied skates may be recognized as a separate, identifiable subgroup. In the remaining species, there appears to be a gradation in the recurvature of the iliac processes, with *Bathyraja smithii* and *Raja spinacidermis* representing the two limits of the sequence (Fig. 3).

Group 2

Pelvic girdle transverse, with iliac region poorly developed; single obturatorial foramen.

This group includes the monotypic genus *Arhynchobatis*, known only from New Zealand.

Group 3

Pelvic girdle simply transverse, with iliac regions moderately developed; one obturatorial foramen; prepelvic processes poorly developed; iliac processes large and recurved.

This group includes all species of the genus *Cruriraja* from South Africa, as well as *C. rugosa* from the Gulf of Mexico.

Group 4

Pelvic girdle transverse, with iliac regions greatly developed; single large obturatorial foramen; iliac processes small; prepelvic processes large.

This group includes both the South African and North American representatives of the family Anacanthobatidae.

The present taxonomy recognizes that groups 1, 2 and 4 form separate families within the Rajoidea, namely Rajidae, Arhynchobatidae and Anacanthobatidae respectively, while group 3 (*Cruriraja*) is considered to be a genus within the Rajidae. However, it is now proposed that, on the basis of the pelvic girdle, a new family Crurirajidae be erected to contain the genus *Cruriraja*. This is further supported by the structure of the clasper. The family will be defined at a later stage in this paper. Similarly, on the basis of the structure of the pelvic girdle, neurocranium and hyomandibular cartilage, the Gurgesiellidae and Pseudorajidae are now recognized to be distinct families (Hulley 1972). Examination of the X-ray photographs of *Psammobatis lima*, *P. scobina*, *P. extenta* and *P. microps* has revealed that the girdles are not unlike those of *Raja clavata* and *R. miraletus* (Figs 3 i, j) and would therefore not necessitate the recognition of a further family at this stage. However, detailed studies of the structure of the claspers of these species is required.

The southern African Rajidae can be grouped into eight distinguishable types, on the basis of the clasper structure:

TYPE A: *Bathyraja smithii* (Müller & Henle).

Claspers very slender and elongate, with club-shaped distal glans; well-developed pseudosiphon on outer dorsal wall; internally, shield and spike absent, but sharp-edged

knife lying beneath projection; rhipidion absent, pseudorhipidion present; dorsal terminal 3 situated laterally to dorsal terminal 2; ventral terminal simple.

Although the single species was referred to the genus *Bathyraja* because of the structure of the rostral bar and appendices (Hulley 1970), there is no doubt that this type of clasper is characteristic of the genus (Ishiyama 1958; Ishiyama & Hubbs 1968; Stehmann 1970). However, Ishiyama & Hubbs (1968) have given diagnostic characters, which are not altogether correct for the genus (Hulley 1970). The pseudorhipidion and pseudosiphon are not wholly confined to the genus: the former is found in *Raja clavata*, *R. straeleni*, *R. miraletus* and *R. alba* (in *Bathyraja smithii* (Hulley 1970: fig. 21), the pseudorhipidion is not labelled, although the associated dorsal marginal cartilage is well developed (Fig. 29)); the latter is present in *Raja radiata*, *R. robertsi* and possibly in *R. wallacei* and *R. caudaspinosa*. Differences based on distribution for the separation of *Bathyraja* from *Breviraja* given by Ishiyama & Hubbs (1968) add to the confusion, and it is now considered that *Bathyraja* is a bipolar, antitropical genus, while *Breviraja* is confined to slope areas in the tropics (Hulley 1970).

In terms of clasper structure, the Japanese subgenus *Rhinoraja* can be separated from *Bathyraja* by its distinct, external pseudosiphon, large dorsal terminal 1 cartilage and elongate ventral marginal cartilage. However, these characters do not seem to be that significant, for a distinct external pseudosiphon is present in *Bathyraja matsubarai*, *B. aleutica* and *B. diploetaenia* (Ishiyama 1958: fig. 3), the dorsal terminal 1 is not markedly reduced in some *Bathyraja* species (Ishiyama 1958: fig. 8), and the ventral marginal is particularly elongate in *Bathyraja trachouros* and *B. abasiriensis*. The subgenus *Rhinoraja* can therefore be distinguished only on the segmented nature of the rostral bar.

It should be noted that the shape of the accessory terminal cartilage in *Bathyraja smithii* (Fig. 24 a) is very similar to that in *Rhinoraja odai* and *Rhinoraja longicauda* (Ishiyama 1958: fig. 11). However, the nature of the rostral bar precludes its identification within the genus *Rhinoraja*.

Type A corresponds to Stehmann's *spinicauda*-type, which includes *Bathyraja spinicauda*, *B. pallida* and *B. richardsoni* (with reservation), and which is now held to be equivalent to the genus *Bathyraja* (Stehmann 1970).

TYPE B. *Raja doutrei* Cadenat; *R. pullopunctata* Smith; *R. lanceorostrata* Wallace; (and probably includes *R. springeri* Wallace and *R. stenorhynchus* Wallace).

Clasper moderately long, naked, with spatulate distal tip more or less dorso-ventrally flattened; pseudosiphon absent; inner dorsal lobe of glans with two clefts, separated by terminal bridge; rhipidion well developed; shield large and covered with pleated epithelia; sentinel usually small and bluntly rounded or absent; spike always present, sometimes hooked; ventral terminal with dorsally convex, outer lateral margin; accessory terminal 1 with asymmetrical, proximal arms; accessory terminal 2 with or without attachment process.

All southern African 'black-bellied' skates are included in this group, which is comparable with the *oxyrhynchus*-group of the eastern North Atlantic (Stehmann 1969, 1970). The group apparently has a world-wide distribution with the

following species: *Raja batis*, *R. oxyrhynchus* and *R. nidarosiensis* in the eastern North Atlantic; *Raja laevis*, *R. oregoni*, *R. bullisi*, *R. floridana* and *R. garricki* in the western North Atlantic; *R. flavirostris* in the western South Atlantic; *Raja rhina* and *R. binoculata* in the eastern North Pacific; *Raja australis*, *R. nasuta* and possibly *Zearaja gudgeri* around Australia and New Zealand; and the species of the subgenus *Tenguji* Ishiyama (*Raja tengu*, *R. pulchra*, *R. macrocauda* and *R. gigas*) in the western North Pacific. These species inhabit the continental shelf area and penetrate the slope regions to between 350 m and 550 m, with a maximum recorded depth of 740 m in the case of *Raja springeri* (Wallace 1967).

The poor degree of development of the distal projection of the accessory terminal 1 appears to be characteristic of all the species, so that the sentinel is poorly developed in the glans. Of the species examined, Ishiyama (1958) reports a massive development of the accessory terminal 1 cartilage in a single species, *Raja pulchra*, where the condition of the cartilage (Ishiyama 1958: fig. 16; 1967: fig. 9) approximates to the condition found in *Raja clavata* and *R. straeleni*. However, there are marked dissimilarities in the detachment process and in the accessory terminal 2 cartilage between *Raja pulchra* and *R. clavata* and *R. straeleni*.

Raja pullopunctata does not possess a sentinel in the glans, as the distal projection of the accessory terminal 1 does not develop (Fig. 24 d).

A well-developed and hooked spine is found in *Raja lanceostrata* and in the Japanese species *R. gigas* (Ishiyama 1958, 1967) and further similarities are shown in the parallelogram-shaped dorsal terminal 1 and the distal projection of the dorsal marginal cartilage (Fig. 31; Ishiyama 1967: fig. 11). However, differences can be seen in the dorsal terminal 2 and 3 cartilages, the proximal elongation of the outer edge of the dorsal terminal 1 cartilage, the expansion of the distal projection of the accessory terminal 1 and the attachment process of the accessory terminal 2. Furthermore, the outer lateral edge of the ventral terminal appears to be comparatively broader in *Raja gigas*.

The spatulate terminal end to the distal projection of the accessory terminal 1 is found in *Raja lanceostrata* (Fig. 24 c), *R. batis* (Hulley 1966: fig. 7) and *R. garricki*, but there are marked differences in the structure of the dorsal terminal 1, ventral terminal and accessory terminal 2 cartilages between the species. The degree of hooking of the accessory terminal 2 in the geographically separated species *Raja batis*, *R. lanceostrata*, *R. macrocauda*, *R. gigas* and *R. garricki* may be considered in terms of parallel evolution.

The possession of an anteriorly arched pelvic bar is peculiar to the southern African species of 'black-bellied' skate (see above) and in the South American species *Raja flavirostris* (Fig. 3 f) and has been confirmed in the case of *R. garricki* and *R. oregoni* from the western North Atlantic. It would appear, therefore, that this condition of the pelvic bar is characteristic of the group as a whole.

'Black-bellied' skates were recognized as a separate group, *Gammaraia*, by Leigh-Sharpe (1925), who proposed the pseudogenus on the basis of external clasper structure. However, this taxon has no nomenclatural standing (Jordan

1925; Bigelow & Schroeder 1953). On the other hand, Ishiyama (1958) identified the Japanese representatives of the group as a separate subgenus, *Tengujei*. Stehmann (1969) has reviewed the taxonomic validity of Ishiyama's subgenus, and proposed that the name *Laeviraja* Bonaparte, 1838 (type-species *Raja oxyrhynchus*) be employed. It appears, however, and has been confirmed (Stehmann 1970), that the name *Dipturus* Rafinesque, 1810 (type-species *Raja batis*) has priority.

TYPE C: *Raja clavata* Linnaeus; *R. straeleni* Poll; *R. miraletus* Linnaeus.

Claspers moderately long, with naked outer surface; some species with pecten on outer dorsal lobe; pseudosiphon absent, but inner dorsal lobe with pocket and cleft; sentinel massively developed, with knife-edged outer lateral margin, fitting into pocket; spike situated distally in sentina; fleshy signal situated proximally at about level of well-developed pseudorhipidion; ventral terminal characteristically J-shaped, with distal protuberance, forming funnel.

Hulley (1970) has pointed out that the species *Raja clavata*, *R. straeleni*, *R. herwigi* and *R. maderensis* form a complex of very closely related species within the genus *Raja*. It would appear that the species *Raja miraletus* can now be identified with the complex. Stehmann (1970) terms this complex the *clavata*-group, and considers it to be a separate subgenus *Raja* Linnaeus (type-species *Raja miraletus*).

Stehmann (1969: 137) is of the opinion that the species *Raja picta* and *R. alba* are members of the subgenus, although they represent 'slightly divergent forms'. This may be true in the case of *Raja picta*, where, although there appear to be marked differences in the structure of the ventral terminal and accessory terminal 2 cartilages, some similarities are shown by the dorsal terminal 1 and 2 cartilages. Furthermore, *Raja picta* possesses a signal. However, *Raja alba* should be considered as a separate subgenus. It will be defined at a later stage.

It has been pointed out (Hulley 1970) that *Raja straeleni* closely resembles *R. clavata*, but that the two were held to be distinct on the basis of colour pattern and of differences in the shield of the clasper glans. There are further differences in the clasper cartilages of the two species. In *Raja straeleni*, the dorsal terminal 1 is narrower and more blunt distally (Figs 16 g, h), the accessory terminal 2 is comparatively broader and distally more pointed (Figs 26 e, f), and the outer lateral margin of the ventral terminal is better developed (Figs 22 e, f). The most marked difference occurs in the dorsal terminal 2 (Figs 18 e, f), which in *Raja straeleni* possesses numerous, small, blunt processes on its outer lateral wall. While the clasper cartilages are species specific without exception (Ishiyama 1958), the differences between *Raja clavata* and *R. straeleni* appear to be minor, suggesting that *R. straeleni* could be regarded as a subspecies of *R. clavata*. Recently, Stehmann (1971b) has re-examined this question, and concludes that the species are distinct.

The subgenus *Raja* appears to be confined to shelf areas of the eastern North Atlantic and eastern South Atlantic (Stehmann 1970), with a bipolar distribution pattern shown by the species *Raja clavata* (Hulley 1966). *Raja*

miraletus is now known to extend into the south-western Indian Ocean (Hulley 1969) and has been reported from the Kerala coast in India (Samuel 1963).

TYPE D: *Raja alba* Lacépède.

Clasper massive, with pecten on outer dorsal surface, but without pseudosiphon; pseudorhipidion well developed; inner dorsal lobe with proximal cleft, but without distal slit or pocket; shield prominent with laminate integument; sentinel massive and situated far distally; spike and signal absent; four dorsal terminal cartilages, with pecten developed from outer lateral margin of dorsal terminal 3; ventral terminal with dorsally convex, wide, outer lateral margin.

While Leigh-Sharpe (1924) considered that *Raja alba* belonged to a separate pseudogenus *Iotaraia*, Stehmann (1969: 136) pointed out that *R. alba* is closely related to the *clavata*-group, although 'in etwas abweichender Richtung entwickelte Formen gelten'. It now appears obvious from the examination of the number and arrangement of the internal cartilages that Leigh-Sharpe's supposition was correct, but his pseudogenus has no taxonomic standing (Jordan 1925; Bigelow & Schroeder 1953).

Firstly, there are four dorsal terminals in *Raja alba*, which are arranged so that they extend distally from the dorsal marginal to the axial tip, so forming the framework of the dorsal lobe (Fig. 33). In this arrangement, *Raja alba* approximates to *Raja radiata*, *R. caudaspinosa*, *R. dissimilis*, *R. confundens*, *R. leopardus* and *R. wallacei*. In the subgenus *Raja*, there are only two dorsal terminal cartilages and the connection between these and the axial tip is formed from connective tissue only. Secondly, *Raja alba* lacks the accessory terminal 3 and 4 cartilages (forming the signal) which are characteristic of the subgenus *Raja*.

It would appear that parallel evolution has occurred in the formation of the pecten, which presumably acts as a holdfast structure. However, as has been pointed out above, the pecten in *Raja miraletus* (subgenus *Raja*) is formed from the dorsal terminal 2, while in *Raja alba*, it is formed by the dorsal terminal 3 cartilage.

Leigh-Sharpe's (1924) classification of *Raja alba* (= *Raja marginata* Lacépède) in the pseudogenus *Iotaraia* has no taxonomic standing. A new subgenus, *Rostroraja*, is therefore proposed to include the species *Raja alba*, and is defined on page 77. The subgenus shows bipolar distribution patterns in the eastern Atlantic (Hulley 1966: fig. 8) and is reported to extend as far north as off Barra Falsa, Moçambique, in the Indian Ocean (Wallace 1967). It inhabits shelf areas from 50 m to 360 m.

Although the following groups are held to be equivalent to their European counterparts, there are differences in the interpretation of the number of dorsal terminal cartilages and in the shape of the axial cartilage.

Stehmann (1969, 1970) considers that in the *fullonica*-type (subgenus *Leucoraja*), *radiata*-type (subgenus *Amblyraja*) and *fyllae*-type (subgenus *Rajella*), the axial is completely recurved on itself, so that it attains a marked J-shape. In *Amblyraja* and *Rajella*, the recurved tip of the axial then connects with a small

dorsal terminal 4 cartilage, to form the framework of the dorsal lobe, while in *Leucoraja*, which has a similarly recurved axial, this cartilage connects directly with the external surface of the dorsal terminal 3. In this subgenus, a dorsal terminal 4 is absent.

These interpretations are now held to be incorrect. It has been found that in the species *Raja dissimilis*, *R. confundens*, *R. caudaspinosa* and *R. leopardus* (Figs 36–39) a dorsal terminal 4 cartilage is present, and consists of a flattened, slightly dorsally convex plate, which runs from the external surface of the dorsal terminal 3 to the axial tip. In these species the cartilage is heavily calcified and well demarcated, both from the axial and from the dorsal terminal 3 cartilages. The axial in these cases is therefore spatulate or only very slightly recurved, and is somewhat similar to the condition of the cartilage in Japanese rajids of the southern form (Ishiyama 1958). In Type E (*Raja radiata*: subgenus *Amblyraja* of Stehmann) the dorsal terminal 4 is not heavily calcified, so that its texture resembles that of the axial. It is held that Stehmann (1969, 1970) has incorrectly termed the calcified proximal end as the dorsal terminal 4 and has referred the distal end to the axial. In *Raja fullonica*, *R. circularis* and *R. naevus* (subgenus *Leucoraja*), Stehmann (1969, 1970) finds no dorsal terminal 4 cartilage, but in the southern African species *Raja wallacei* (Fig. 35), which is obviously of the same subgenus, a dorsal terminal 4 cartilage, which is usually well calcified, is easily identifiable. Therefore, the axial cartilage is spatulate or only slightly recurved. Furthermore, the subgenera *Amblyraja*, *Leucoraja* and *Rajella* show an obvious sequence, especially in regard to the dorsal terminal 3 cartilage, when considered in the light of these findings.

TYPE E: *Raja radiata* Donovan; *R. robertsi* Hulley.

Claspers short and club-like; pseudosiphon in outer dorsal lobe; spur well developed, forming outer border of distal cleft; sentinel partly covering spike; pent extending distally from rhipidion; distal end of prominent shield with laminate integument; four dorsal terminal cartilages; ventral terminal typically J-shaped; accessory terminal 1 characteristic, with concave dorsal surface, enveloping the accessory terminal 2.

The pseudogenus *Deltaraia* was proposed by Leigh-Sharpe (1924) to include the species *Raja radiata* and *R. naevus*. However, Stehmann (1970) has grouped the species *Raja radiata* and *R. hypoborea* as a separate subgenus, *Amblyraja* Malm, 1877, and, mainly on the basis of clasper structure, has shown that *Raja naevus* should be referred to the subgenus *Leucoraja* Malm, 1877.

From its morphometry and the presence of a pseudosiphon in the claspers of the juvenile male type, Hulley (1970) has suggested that *Raja robertsi* should be included with *R. radiata*, so forming a group which encompasses the species *Raja duellojuradoi*, *R. frerichi* and *R. georgiana* in the western South Atlantic, *R. jensenii* from the western North Atlantic and *R. badia* from the Gulf of Panama. The bipolar distributional pattern of the twin species has already been pointed out (Krefft 1968b). All species of this subgenus inhabit slope areas of the archibenthal and some penetrate to abyssal depths. It should be pointed out that *Raja badia* is at present the only species of the subgenus not found in the Atlantic.

TYPE F: *Raja wallacei* Hulley.

Claspers short and spatulate; dermal denticles usually present externally; cavity in musculature of outer dorsal lobe usually present (? pseudosiphon); proximal slit bordered by roll; distal cleft bordered by small spur, usually covered by integument; promontory present; spike and sentinel small and situated far distally; rhipidion fan-shaped; four dorsal terminal cartilages, with dorsal terminal 3 forming small spur.

This type of clasper structure is comparable with that of the *fullonica*-type of Stehmann (1969), the species of which have been included in the subgenus *Leucoraja* Malm, 1877. While the subgenus is represented by three species in the eastern North Atlantic, only one species is known from southern African waters, where it has been recorded at depths varying from 73 m to 445 m from west of Cape Point north to the Limpopo River mouth (Wallace 1967). Therefore, *Raja wallacei* like *R. fullonica*, shows a depth distribution into the upper limits of the archibenthal. Recently, Stehmann (1971c) has recognized a further species of the subgenus, *Raja (Leucoraja) leucosticta*, from the tropical waters of West Africa. This species had previously been confused with *Raja ackleyi*, Garman.

It has been pointed out that the cavity found on the outer surface of the dorsal lobe of the glans is formed in a different manner to the pseudosiphon and is related only to the musculature. However, the two cavities may prove to be related. As can be seen (Figs 34, 35) in both *Raja radiata* and *R. wallacei*, the dorsal terminal 3 cartilage is developed into a laterally projecting spur, which is large and S-shaped in *Raja radiata*, but smaller and less well developed in *Raja wallacei*. However, in the form and orientation of the accessory terminal 1 and 2 cartilages and in the ventral terminal, *Raja wallacei* shows a closer similarity to *Raja caudaspinosa*, *R. confundens*, *R. leopardus* and *R. dissimilis* (Figs 24, 26). Stehmann (1970) indicates an accessory terminal 3 cartilage in *Raja fullonica*, but not in *R. circularis* and *R. naevus*. Only two accessory terminals are found in *Raja wallacei*.

TYPE G: *Raja caudaspinosa* Von Bonde & Swart; *R. leopardus* Von Bonde & Swart; *R. confundens* Hulley; *R. dissimilis* Hulley; (and probably *R. ravidula* Hulley).

Claspers small and short, with or without dermal denticles on outer dorsal lobe; some specimens with a small cavity in musculature; two clefts or a cleft and a slit present; spike and sentinel small; rhipidion fan-shaped and usually associated with pent; shield not well developed; axial cartilage spatulate; four dorsal terminal cartilages; dorsal terminal 3 pointed, but not developed into lateral spur.

Species with this type of clasper structure have been grouped into the subgenus *Rajella* Stehmann (type-species *Raja fyllae*), which, in the North Atlantic, may also include the species *Raja garmani*, *R. erinacea*, *R. ocellata* and *R. lentiginosa*. On the basis of *Raja fyllae*, Stehmann (1970) confines the subgenus to the archibenthal, but depth distribution records for the South African species (Hulley 1970) indicate that some of the species may occupy the shelf areas (*Raja leopardus*), while others are known only from abyssal depths (*Raja dissimilis*, *R. ravidula*).

The presence of four dorsal terminal cartilages and the shape of the axial have already been discussed above in relation to Stehmann's ideas. Similarities in the accessory terminal 1 and 2, dorsal terminal 1 and ventral terminal cartilages, and the framework arrangement of dorsal terminals 2-4, can be seen between this group and Type F. However, the dorsal terminal 3 is differently developed.

TYPE H: *Cruriraja parcomaculata* (Von Bonde & Swart); *C. triangularis* Smith; *C. rugosa* Bigelow & Schroeder; (and probably includes *C. durbanensis* (Von Bonde & Swart)).

Claspers small and spatulate; dermal denticles usually absent, but one species with denticles on ventral border; thorn present on lateral edge of dorsal lobe, eperon on ventral lobe; inner dorsal lobe with pseudosiphon; rhipidion small and closely attached; knob and sentinel present; spike tongue-shaped and situated medially; axial cartilage characteristically J-shaped; dorsal terminal 1 enclosed by axial limb; terminal bridge between axial and accessory terminal 2.

This particular type of clasper structure is readily distinguished from all other types and is associated with the genus *Cruriraja*. In fact, it is further removed from the typical rajid type than *Bathyraja*, and, as in the case of the Anacanthobatidae, suggests that a further family within the Rajoidea be distinguished. Examination of the pelvic girdles and neurocrania seems to agree with this. A new family will therefore be defined (see page 78).

The genus is, at present, known only from two areas, the southern African coast (*Cruriraja durbanensis*, *C. parcomaculata* and *C. triangularis*), where the species inhabit shelf areas and the upper regions of the archibenthal, and the Gulf of Mexico (*Cruriraja atlantis*, *C. poeyi*, *C. rugosa* and *C. cadenati*), where they are recorded from archibenthal regions.

As has been pointed out, the predorsal caudal vertebral count (Vprd) is not species specific, but it would seem that in certain cases it may be used to distinguish between closely related species (Stehmann 1970; Hulley 1970) and may even be used for taxonomic discrimination at the subgeneric level. Stehmann (1970) suggests that *Raja alba* may be separated from the subgenus *Raja* by both Vtr and Vprd counts. While there appears to be some overlap in Vprd values for *Raja alba* and *R. clavata* in the eastern North Atlantic (Stehmann 1970: fig. 14), the counts for the southern African specimens appear to be well separated (Fig. 47), substantiating the recognition of *Rostroraja*, which was based on clasper structure.

The true significance of this method of application is open to question, since the separation of species on the basis of Vprd counts is not always supported by clasper distinctions. For example, in the southern African subgenus *Rajella*, two distinct species groups can be recognized (Fig. 47), but the clasper structure of the species *Raja leopardus*, *R. caudaspinosa*, *R. confundens* and *R. dissimilis* are almost identical. It is probable that with increasing knowledge, species of this particular subgenus, with intermediate values in Vprd count, may be found, as with *Bathyraja* and *Dipturus*.

Apparent differences seem to exist between *Bathyraja pallida* (Vprd 66–67) and *B. spinicauda* (Vprd 77–82) (Stehmann 1970). However, within this genus intermediate values have been recorded (Ishiyama 1958; Hulley 1970). Similarly, the high Vprd values for *Raja (Dipturus) nidorosiensis* (Stehmann 1970) are approximated by the southern African *Dipturus* species, *Raja pullopunctata* and *R. lanceorostrata* (Table 1), and are exceeded by the Japanese species *Raja macrocauda* and *R. gigas*.

While the shape of the anterior and posterior fontanelles may be species specific in bathyrajid species (Ishiyama 1958), marked differences are not evident in other rajids. It would appear therefore that neurocranial characters are mainly applicable above the species level. There can be no doubt that characters such as the structures of the rostral cartilage and appendices are of significant value in taxonomy (Bigelow & Schroeder 1948; Ishiyama 1952, 1958; Stehmann 1970). These have already been employed in the recognition of genera in southern African Rajidae (Hulley 1970). However, it appears that certain cranial characters can be used to separate the proposed subgenera of *Raja*, while the majority can best be interpreted in terms of the phylogenetic interrelationship between these subgenera.

Stehmann (1970) suggests that the length of the rostrum in relation to the cranial length may be used for the grouping of species and for the interpretation of phylogenetic relationships. He has pointed out that the rostral length is greater than the 'cranial length' (not cranial length of Hubbs & Ishiyama (1968: fig. 1) but equal to total cranial length minus rostral length) in *Dipturus*, but less than the 'cranial length' in all other subgenera of *Raja*. While high values for the rostral length/cranial length proportion are found in *Dipturus* species (Table 2), equally high values have been found for *Rostroraja*, and values above 50% have been found in *Raja confundens* and *R. ravidula*. Furthermore, the course of the hypothetical line drawn from the tip of the rostrum through the ophthalmic foramen appears to be a complex function of the rostral length and cranial width, and bears little relation to the suggested subgeneric groupings. However, *Dipturus* is characterized by the forward extension of the anterior fontanelle, so that in all species of this subgenus the rostrum is grooved, there being no definite anterior limit to the fontanelle. The extent of the rostral grooving varies in the different species (Fig. 50) and its presence can be regarded as primitive, since *Dipturus* shares this character with the Rhinobatidae.

The size of the nasal capsules varies to some extent. Enlarged capsules are found in *Raja robertsi*, *R. dissimilis*, *R. ravidula* and *R. spinacidermis* (Figs 52 D; 53 D; 54 D, E), a fact which seems to be correlated with depth distribution rather than proposed groupings, since these species (of different subgenera) are all found to occur at depths of 1 000 metres or more (Hulley 1970). Although no comparison was made of the number of Schneiderian and secondary folds or the number of sensory cells per unit area between these species and the continental shelf species, the massive development of the nasal capsules would substantiate the theory that olfaction is probably of greater importance in a

deep-water habitat (Weichert 1951). As with the rostral length, the orientation of the nasal capsules bears little relationship to the groupings, but their shape, which is altered by the degree of development of the preorbital processes, may be of importance.

The preorbital process is well developed only in *Raja* and *Rostroraja* (Figs 51; 52 A), a character which these subgenera share with both the Rhinobatidae and with *Bathyraja* (Fig. 49 A; Ishiyama 1958: fig. 28; Stehmann 1970: fig. 27). This character, together with the orientation of the nasal capsules, may be employed to distinguish *Raja* and *Rostroraja* from the other subgenera. Similarly, the presence of a comparatively large postorbital process in *Bathyraja smithii* (Fig. 49 A) and other bathyrajids (Ishiyama 1958: fig. 28; Stehmann 1970: fig. 27) may be used as a taxonomic character for distinguishing this genus.

A marked degree of constriction of the neurocranium across the orbital region is characteristic of *Rajella* (Figs 53; 54 A, D), but the noticeable anterior displacement of the optic foramen and the position of the anterior cerebral vein foramen in this subgenus and in *Amblyraja* and *Dipturus* are best interpreted in terms of their phyletic relationship. The possession of a small orbito-nasal canal foramen in *Cruriraja parcomaculata* (Fig. 49 F) could be taxonomically employed, but further evidence is required from other species of this genus.

The jugal arches are angular and prominent in *Amblyraja* (Figs 52 D, E), in which they project as wing-like extensions from the laterally expanded auditory capsules. Angular arches are also found in *Rajella* (Figs 53; 54 A, D), but are directed postero-laterally from moderately expanded auditory capsules. In *Raja*, *Leucoraja* and *Rostroraja* (Figs 51; 52 A; 54 F), the jugal arches are more or less evenly curved and project posteriorly, while in *Dipturus* (Fig. 50) they are comparatively smaller and do not disrupt the contour of the auditory capsule region. In *Raja spinacidermis* (subgenus *Malacoraja*) (Fig. 54 E) the arches are poorly developed and thin, while in *Cruriraja* (Figs 49 D, E) they are particularly thin at their junction with the process of the hyomandibular facet.

The taxonomic significance of the shape and position of the posterior fontanelle is open to question, since these characters and even the differentiation into two posterior fontanelles vary within the same species (Stehmann 1970: figs 17, 19, 20, 24). As has been pointed out above, the shape of the anterior fontanelle is species specific in *Bathyraja*, and its shape and degree of development in other rajids are only suggestive of the subgeneric groupings, which are based on clasper structure.

In conclusion, it should be pointed out that while certain neurocranial characters, such as the constriction of the orbital region, the degree of development of the preorbital and postorbital processes, the orientation of the nasal capsules and jugal arches, and the shape and extension of the anterior fontanelle, may be used in combination as taxonomic characters at the subgeneric and generic level, their significance is more difficult to interpret than that of the clasper structure. However, they may be suitably employed in elucidating phyletic interrelationships.

To summarize, the southern African Rajidae can be identified within the framework of the genera and subgenera proposed by Stehmann (1970), which is based mainly on clasper structure, as follows:

Family **Rajidae**

Genus *Bathyraja* Ishiyama, 1968

type-species *Raja isotrachys* Günther, 1877

species: *Bathyraja smithii* (Müller & Henle, 1841)

Genus *Raja* Linnaeus, 1758

type-species *Raja miraletus* Linnaeus, 1758

1. subgenus *Raja* Linnaeus, 1758

type-species *Raja miraletus* Linnaeus, 1758

species: *Raja clavata* Linnaeus, 1758; *Raja straeleni* Poll, 1951

2. subgenus *Dipturus* Rafinesque, 1810

type-species *Raja batis* Linnaeus, 1758

species: *Raja doutei* Cadenat, 1960; *Raja pullopunctata* Smith, 1964; *Raja springeri* Wallace, 1967; *Raja lanceorostrata* Wallace, 1967; *Raja stenorhynchus* Wallace, 1967.

3. subgenus **ROSTRORAJA** subgen. nov.

type-species *Raja alba* Lacépède, 1803

Definition

Clasper massive, with pecten on outer dorsal surface, but without pseudosiphon; pseudorhipidion well developed; inner dorsal lobe with proximal cleft, but without distal slit or pocket; shield prominent with laminate integument; sentinel massive and situated far distally; spike and signal absent; four dorsal terminal cartilages, with pecten developed from outer lateral margin of dorsal terminal 3; ventral terminal with dorsally convex, wide, outer lateral margin. Rostrum produced and elongate, its length more than 50% of cranial length; nasal capsules moderately developed and orientated anteriorly; anterior cerebral vein foramen ventral.

4. subgenus *Amblyraja* Malm, 1877

type-species *Raja radiata* Donovan, 1808

species: *Raja robertsi* Hulley, 1970

5. subgenus *Leucoraja* Malm, 1877

type-species *Raja fullonica* Linnaeus, 1758

species: *Raja wallacei* Hulley, 1970

6. subgenus *Rajella* Stehmann, 1970

type-species *Raja fyllae* Lütken, 1888

species: *Raja caudaspinosa* Von Bonde & Swart, 1923; *Raja leopardus* Von Bonde & Swart, 1923; *Raja confundens*

Hulley, 1970; *Raja dissimilis* Hulley, 1970; *Raja ravidula* Hulley, 1970

Stehmann (1970) has defined a further subgenus, *Malacoraja*, based on *Raja mollis*. It is now considered that *Raja mollis* is synonymous with *Raja spinacidermis* Barnard (Hulley 1970). As no adult male specimen of this species has yet been taken, this identification is based on characters other than the clasper structure. Marked differences in the rostral length, the orientation and massive development of the nasal capsules and the poorly developed jugal arches, serve to distinguish *Malacoraja* from all other subgenera.

7. subgenus *Malacoraja* Stehmann, 1970

type-species *Raja spinacidermis* Barnard, 1923

The family *Crurirajidae* is now erected to include all species of the genus *Cruriraja*, which were formerly identified with the *Rajidae*.

Family **CRURIRAJIDAE** fam. nov.

Definition

Pectorals with radials of ordinary form, without lateral processes; outer margins of pelvics deeply notched, to form an anterior, limb-like structure, consisting of three articulated segments, externally distinct from the posterior, fin-like lobe of the pelvic; tips of anterior rays of pectorals falling short of tip of rostral cartilage; two dorsal fins. Otherwise external characters as for suborder.

Claspers small and spatulate; dermal denticles usually absent on dorsal border; thorn present on lateral edge of dorsal lobe, eperon on ventral lobe; inner dorsal lobe with pseudosiphon; rhipidion small and closely attached; knob and sentinel present; spike tongue-shaped and situated medially; axial cartilage characteristically J-shaped; dorsal terminal 1 enclosed by axial limb; terminal bridge between axial and accessory terminal 2.

Pelvic girdle simply transverse, with iliac regions moderately developed; one obturatorial foramen; prepelvic processes poorly developed; iliac processes large and recurved.

Neurocranium without preorbital and postorbital processes; orbito-nasal canal foramen small; jugal arches poorly developed; posterior cerebral vein foramen absent.

Genus *Cruriraja* Bigelow & Schroeder, 1948

type-species *Cruriraja atlantis* Bigelow & Schroeder, 1948

species: *Cruriraja parcomaculata* (Von Bonde & Swart, 1923);
Cruriraja durbanensis (Von Bonde & Swart, 1923); *Cruriraja triangularis* Smith, 1964.

An interesting case is presented in the family *Anacanthobatidae*, which at present contains two genera, *Anacanthobatis* and *Springeria*. The discussion is only in relation to *Anacanthobatis marmoratus* and *A. americanus*, so that before definite taxonomic changes are made, *A. longirostris* from the Gulf of Mexico and *A. borneensis* from the South China Sea should be examined.

Basic major differences in clasper structure can be seen between *Anacanthobatis marmoratus* and *A. americanus* (Figs 10, 11, 43, 44), the most important of

which is the absence in *A. americanus* of the ventral terminal cartilage. Hence there is a lack of an associated shield and eperon in the clasper glans in this species. Probably associated with this is the fact that the spike and sentinel in *Anacanthobatis americanus* are positioned laterally and are capable of rotation (Fig. 11). Furthermore, *Anacanthobatis marmoratus* lacks an external pseudosiphon, while in *A. americanus* there is an external pseudosiphon. Examination has shown that the structure and orientation of the cartilages is different in the two species.

It therefore appears that, on the basis of clasper structure, these two species should not be referred to the same genus and that the family Anacanthobatidae, as defined at present, may be diphyletic. In terms of priority, the South African species *Anacanthobatis marmoratus* becomes the type-species for the genus *Anacanthobatis*, which is then considered to be monotypic, while *Anacanthobatis americanus* should be referred to a new genus. Although Bigelow & Schroeder (1953) consider that a second South African species, *Anacanthobatis dubius* Von Bonde & Swart, 1923, can be referred to the genus *Springeria*, they later (1962) hold that *A. dubius* is probably an immature *A. marmoratus*, so that Wallace (1967) has synonymized the two under *Anacanthobatis marmoratus*. As the type specimens of these species are missing, this synonymy has been tentatively accepted.

Family **Anacanthobatidae**

Genus *Anacanthobatis* Von Bonde & Swart, 1923

type-species *Anacanthobatis marmoratus* Von Bonde & Swart, 1923

Genus *Springeria* Bigelow & Schroeder, 1951

type-species *Springeria foliorostris* Bigelow & Schroeder, 1951

species: *Springeria ori* Wallace, 1967

PHYLETIC INTERRELATIONSHIPS

White (1937) and Saint-Sienne (1949) consider that recent elasmobranchs, which do not include the archaic families Heterodontidae and Hexanchidae, arose from a common ancestor, which was not unlike *Palaeospinax* (family Heterodontidae). A monophyletic origin is also held by Disler (1966) on the basis of the embryonic development of *Trygon pastinacea*. Examination of the structure of the neurocranium led Holmgren (1941) to suggest a diphyletic origin for the recent Elasmobranchii, a view supported by Hasse's (1885) observations, and by Melouk (1947), who considers that the benthic mode of life is more primitive. However, it has now been shown that the features stressed by Holmgren (1941) represent minor ontogenetic modifications, and Schaeffer (1967) therefore considers separate origins for galeoids, squaloids and batoids, the latter probably arising from some benthic hybodont stock.

Within the batoid line, it is generally considered (Regan 1906; Leigh-Sharpe 1924; Holmgren 1941; Melouk 1947; Gregory 1951) that the Rajoidea

arose from the Rhinobatidae, since they show a strong resemblance in dentition and in the possession of longitudinal folds on the tail. Ishiyama (1958), in comparing skull, rostral and clasper structure, arrives at the following conclusions:

- (1) Rajids have arisen from a rhinobatid-like stock rather than a platyrhinid, since there is a trend in the reduction of basal segments in the myxopterygium and in denticulation, and a trend in the development of the clasper siphon.
- (2) The genus *Bathyraja* originated directly from the ancestral stock, with subsequent neotonous modification of the rostral cartilage, but with retention of primitive characters in the clasper.
- (3) Both *Raja* and *Rhinoraja* species can be derived from the bathyrajid-type, with the genus *Raja* representing an earlier split.
- (4) Amongst the species of the genus *Raja*, those of the subgenus *Tenguji* (= *Dipturus*) are considered to be more primitive, since they show primitive characters in their rostral structure.

Stehmann (1970) has presented a phylogeny for the rajid species of the eastern North Atlantic, which, as has been shown above, form subgeneric groupings identical with those of the species of the southern African region. This phylogeny is based on clasper anatomy, rostral structure and geographic distribution. Stehmann (1970) selects the pseudosiphon as the definitive character, so leading to a division of the rajids into Rajidae I (without a pseudosiphon—*Dipturus*, *Raja*) and Rajidae II (with a pseudosiphon—*Bathyraja*, *Rhinoraja*, *Leucoraja*, *Amblyraja*, *Rajella*) (Fig. 55).

There is no doubt that the pseudosiphon is a primitive structure, and that

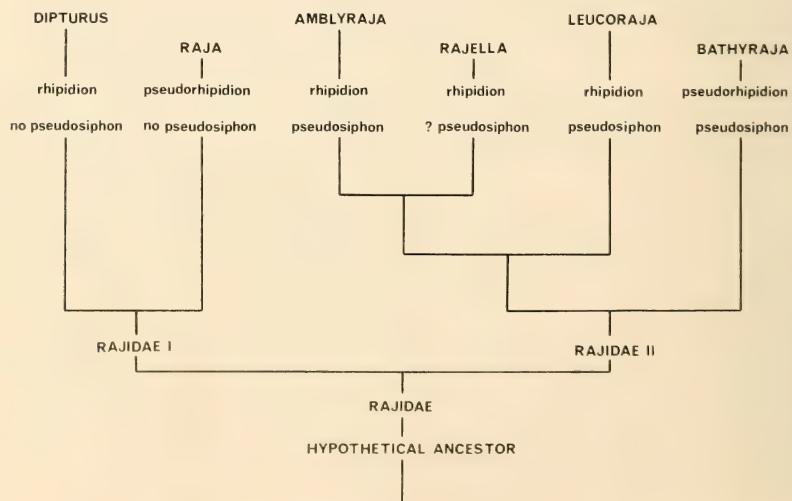


Fig. 55. Relationship within the Rajidae as suggested by Stehmann (1970), showing the possession of rhipidion, pseudorhipidion and pseudosiphon.

Ishiyama's (1958) interpretation of the ancestral nature of the genus *Bathyraja* is correct, for in this genus the ventral terminal cartilage is simple and not expanded into a lateral shield, the accessory terminal is reminiscent of *Rhinobatos*, and the axial cartilage is bluntly pointed rather than spatulate. Ishiyama (1958) also considers that the primitiveness of the group, especially the species *Rhinoraja kuyiensis*, can be seen in the possession of scale on the ridge, and in the simple construction of the dorsal terminal 1 cartilage. However, it should be pointed out that the development of dermal denticles may be secondary, e.g. *Raja wallacei*, *R. leopardus*, *R. confundens*, and that the position of the dorsal terminal 1 in *Rhinoraja kuyiensis* probably represents the case most removed from *Rhinobatos*, if we accept Ishiyama's theory of rotation of the dorsal terminal 1 from the ventral to the dorsal side of the clasper.

The genus *Bathyraja* represents a direct modification of the basic, ancestral stock, in which, by the process of neotony, the rostral bar is reduced to a thin rod. This may be related to an increased advantage in grubbing (Ishiyama 1958). The widespread, discontinuous, antitropical distribution of the genus (Hulley 1970) supports its antiquity, as does the possession of comparatively well-developed preorbital and postorbital processes in the neurocranium. *Rhinoraja*, with its segmented rostral bar, represents a further specialization of the bathyrajid condition, which would allow for even greater flexibility of the snout.

If the subgenus *Raja* is closely associated with the subgenus *Dipturus* (Stehmann 1970), then it must be accepted that the rhipidion was evolved twice (Fig. 55). However, the persistence of the pseudorhipidion, i.e. retention of a well-developed dorsal marginal cartilage, is evidence of an association of the subgenus *Raja* with the bathyrajid condition. This is supported by the simple form of the dorsal terminal 1 cartilage, with its proximal shelf for the insertion of the *m. dilatator*, conditions which approximate those found in Japanese bathyrajids (Ishiyama 1958: fig. 8). Furthermore, in the subgenus *Raja* the axial cartilage retains its primitive, terminal point. The proximal position and orientation of the dorsal terminal 2 can then be explained as a continuation of the trend in development of the dorsal terminal 2 and 3 cartilages from their position in *Rhinobatos* (Fig. 45) through some intermediate bathyrajid-like form (Ishiyama 1958: figs 10 K, D). The subgenus *Raja* may therefore be regarded as a side branch of the ancestral stock, close to the bathyrajid condition (Fig. 57), in which the pseudosiphon was lost (possibly with complete dorsal rotation of the dorsal terminal 1) and the ventral terminal more developed, but in which the neotonous condition of the snout was never retained. Rather there was a simple length reduction of the snout from its ancestral condition. In support of this, the neurocranium of *Raja* shows a closer affinity with that of *Bathyraja*, rather than with that of *Dipturus*. The preorbital process is well developed in *Raja* and *Bathyraja*, while its size and position in *Dipturus* approximates the condition in *Amblyraja*, *Rajella* and *Leucoraja*. Furthermore, the position of the foramen for the anterior cerebral vein in *Raja* approximates the bathyrajid

condition, while in *Dipturus*, *Amblyraja*, *Rajella* and *Leucoraja*, it is displaced dorsally.

The acceptance of this proposition would mean that the rhipidion was only evolved once (Fig. 56), while the pseudosiphon, whose function is unknown, was lost in two separate evolutionary lines. This appears to be more acceptable than Stehmann's suggestion.

The subgenus *Rostroraja* appears to be associated with those groups in which the ancestral pseudorhipidion is retained. As has been pointed out above, it differs markedly from the subgenus *Raja* in axial shape, in the framework arrangement of the dorsal terminal cartilages and in the heavy development of the lateral edge of the ventral terminal cartilage. The possession of an elongate snout (the anterior fontanelle of which is not primitive) and a discontinuous distribution indicate a greater age for this group. This is supported by the Vprd count, which for *Raja alba* is quite distinct from that of the subgenus *Raja*. The higher count in *Rostroraja* (Fig. 47) is indicative of its greater age, so that this subgenus represents an early split from the *Bathyraja/Raja* line of evolution. The extreme ventral position of the anterior cerebral vein foramen would indicate a specialized condition, when compared with its median position in *Raja* and *Bathyraja*.

Some criticism may be levelled against this theory in terms of the accessory terminal cartilages, of which there are four in the subgenus *Raja*, two in *Rostroraja*, but only one in bathyrajids. However, a marked similarity can be seen between the extension of the ventral marginal cartilage of bathyrajid species and the tightly bonded accessory terminal 1 of *Rostroraja* and *Raja*.

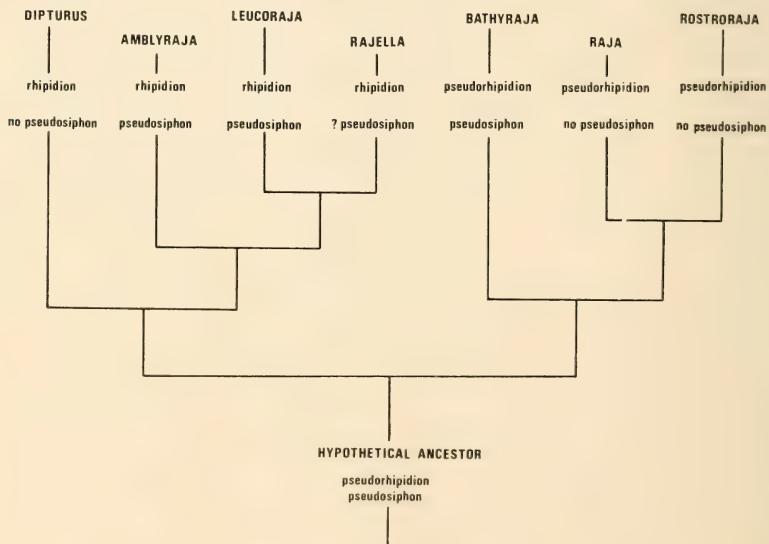


Fig. 56. Proposed relationship within the Rajidae, adapted from Fig. 57, showing the possession of rhipidion, pseudorhipidion and pseudosiphon.

Furthermore, the accessory terminals 3 and 4 might well be derived from laterally positioned dorsal terminal elements.

On the evidence presented by their distribution (Hulley 1966: fig. 8), both *Raja* and *Rostroraja*, which developed as shelf species from the boreal bathyrajid ancestors, penetrated the Mediterranean Subregion at the beginning of the Pleistocene glacial period (Klausewitz 1968). Possibly at this same time, a complete north-south distribution on the continental shelf may have been attained by *Rostroraja*, since equatorial cooling was pronounced along the eastern shores of the Atlantic (Hubbs 1952). The subsequent increase in sea temperatures at the end of the last glacial would have given rise to (?) equatorial submergence in the case of *Raja alba* (Hulley 1966), and would have induced a southerly spread of the subgenus *Raja*. This would then support Crowson's (1970) and Parin's (1970) ideas on the correlation between group age and distribution.

All other rajid subgenera in the eastern Atlantic can be derived from an ancestor, which possessed a pseudosiphon and long snout, and which had developed a shield and fleshy rhipidion (Fig. 57). In all, the longitudinally segmented pattern of the dorsal terminal cartilages, which form the framework of the dorsal lobe, is retained. This ancestor probably inhabited the archibenthal regions in boreal and antiboreal latitudes.

The subgenus *Dipturus* represents an early split from this ancestor, as indicated by the world-wide distribution of the group, in which the primitive, rigid, rostral bar, with elongate anterior fontanelle and grooved rostrum was retained, but in which the pseudosiphon was lost. The group apparently colonized the edge of the shelf and upper regions of the archibenthal, a fact which probably allowed for their subsequent spread to all oceans (Stehmann 1970). The low Vprd values in the southern African species of *Dipturus* seem to

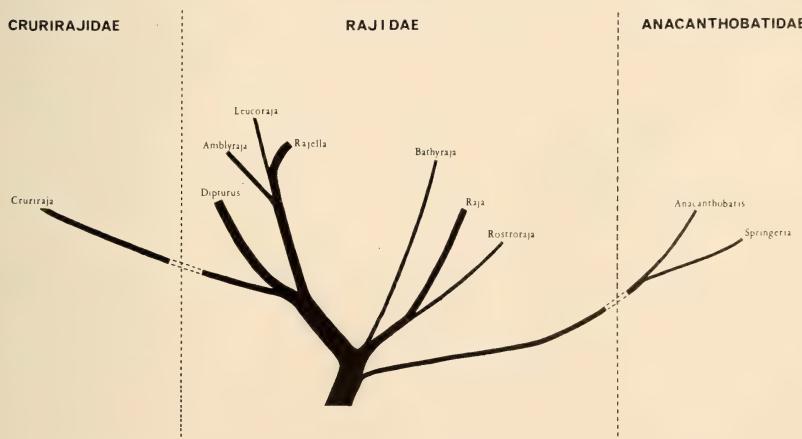


Fig. 57. Phyletic interrelationships as suggested by southern African Rajidae. The thickness of the lines corresponds to the relative number of species.

indicate that the group is not particularly ancient, but, as has been pointed out above, in several Japanese species of this subgenus, the count is somewhat higher (Ishiyama 1958). A strict interpretation of Vprd count to phylogeny would therefore mean that the origin of the subgenus *Dipturus* must be sought in areas other than the eastern North or eastern South Atlantic.

Examination of the clasper structure of *Breviraja colesi* (Ishiyama & Hubbs 1968) would seem to suggest that this genus can be closely associated with the *Dipturus* group. The species of this side branch penetrated the abyssal regions of the western central Atlantic, and, as in bathyrajids, retained the neotonous condition of the snout as an increased advantage in grubbing.

Although Stehmann (1970) suggests an association of *Amblyraja*, *Leucoraja* and *Rajella* with the bathyrajid condition, Rajidae II (Fig. 55), a closer affinity with the subgenus *Dipturus* is now evident. Not only are there similarities in the structural arrangement of the cartilages and in the presence of a well-developed rhipidion and strongly developed shield, but there are also marked resemblances in the dorsal terminal 1, ventral terminal and accessory terminal 1 cartilages. Similarly these subgenera share common neurocranial characters with *Dipturus*. They do not have well-developed praeorbital processes and the position of the anterior cerebral vein foramen is always dorsal to the optic foramen.

In terms of the pseudosiphon, it would appear that *Amblyraja* might be considered to be ancestral to both *Leucoraja* and *Rajella*, and Stehmann (1970) goes as far as to derive *Rajella* directly from *Amblyraja*. Counts of the number of predorsal caudal vertebrae show a low value for *Amblyraja* (48–52) and a high value for *Rajella* (55–73), suggesting that *Rajella* might be the more primitive. However, the subgenus *Amblyraja* has a much wider distribution in the Atlantic than either of the other two subgenera, and, in terms of the evolution of the clasper, particularly the retention of the pseudosiphon, may be considered to be an early split from the *Leucoraja/Rajella* line.

The phylogenetic position of *Raja spinacidermis*, as based on Vprd count, is not clear, although comparatively high values indicate an age equivalent to that of the subgenus *Amblyraja*, with the possibility of an even greater age. It must be emphasized that the validity of *Malacoraja* as a separate subgenus rests solely on its peculiar spination pattern, rostral length, nasal capsule orientation and depth distribution, the taxonomic values of which are uncertain. But until examination of the clasper structure can be made, Stehmann's (1970) proposals must be accepted.

The clasps of the genus *Cruriraja*, which possess a shield and pitted rhipidion, but lack an external pseudosiphon, bear a marked resemblance to those proposed for the ancestral *Dipturus* stock. However, there are major differences, especially in the arrangement of the dorsal terminals. The comparatively high values of the Vprd count in both *Cruriraja parcomaculata* and *C. triangularis* would seem to indicate an early split from the ancestral to the crurirajid condition (Fig. 57). The structure of the clasper of the mid-western Atlantic species *Cruriraja rugosa* appears to be much simpler than that of the

southern African species, particularly as regards the accessory terminals. While noting that a simpler structure may not necessarily mean more ancestral (Mayr 1969), the structure of the shield in *Cruriraja rugosa* approximates more closely to the ancestral condition. Furthermore, the Vprd count for *Cruriraja rugosa*, which is based on a single specimen only, is slightly higher than that of the southern African species. However, before theories are advanced as to the possible method of evolution, i.e. west to east migration (cf. Clinidae: Springer 1970), the archibenthal and abyssal rajid fauna of the tropical western Atlantic needs further examination.

The evolutionary position of the Anacanthobatidae is not evident at this stage, for, as has been pointed out, on the basis of the clasper structure of *Anacanthobatis marmoratus* and *A. americanus*, the group as defined as present appears to be diphyletic. *Anacanthobatis americanus*, which is now considered to belong to another genus, appears to be closer to the *Dipturus* ancestral stock and its lack of a shield can be seen as the ultimate case in the general trend in reduction of that structure, which is shown by *Amblyraja*, *Leucoraja* and *Rajella* species. The possession of similarly formed pelvic girdles but structurally different clasper arrangements can therefore only be interpreted as an early origin for the family (Fig. 57). This theory is tentatively advanced until examination of further anacanthobatid material becomes possible.

In conclusion, it must be emphasized that, unlike the majority of South African marine fishes, which appear to have their origin in the central Indo-Pacific (Smith 1961), the Rajidae show a closer affinity with the eastern North Atlantic. This is not surprising, since the tropical East African region apparently forms a barrier zone, in which rajids have never been recorded (Playfair & Günther 1866; Peters 1868; Fourmanoir 1954; Smith & Smith 1963).

A warm-water barrier zone to temperate species has apparently been in existence in this region since early Permian times, when a palaeo-equatorial current impinged on the African-Arabian coastline (Frakes & Crowell 1970). This is well before the proposed mid-Cretaceous origin of the Rajidae (White 1937). During the Pleistocene period, when major colonization of the southern African shelf region was in progress (M. M. Smith 1970), this tropical barrier was probably not broken down, as it was in the tropical eastern Atlantic (Hubbs 1952). The following hypothesis is offered in support.

Biggs (1966), on the basis of endemism in fishes of oceanic islands, has shown that Pleistocene temperature fluctuations have not been the same in all oceans. Similar conclusions have been reached by Ericson *et al.* (1964) and Emiliani (1970) on palaeontological evidence.

During the periods of glaciation, the Northern Hemisphere was characterized by a southern spread of the polar ice. This had a marked effect in lowering sea temperatures, especially where the thermal capacity of the ocean was small and where the ice was in direct contact with the sea, e.g. North Atlantic. This resulted in a southerly displacement of certain species. However, in the Southern Hemisphere, glaciation was comparatively slight (Charles-

worth 1957). Coupled to this is the fact that the Indian Ocean is bounded to the north by a continental mass, rather than an ice-cap, so that while extensive glaciation may have occurred in the Himalayan region, this only had a localized effect on the sea temperatures.

Therefore, because of the lack of a northern boundary ice-cap and because the major portion of the Indian Ocean is situated south of the equator, it is held that the tropical marine environment of the East African region did not vary during the Pleistocene. This is supported by Cox (1927: 18), who states for Mollusca that 'there is no evidence for the invasion of the area by colder water forms in Pleistocene times'. The East African region has therefore always formed an effective barrier zone to the migration of the Rajidae.

The southern African region has therefore been one of secondary colonization rather than primary development, and the Rajidae can be envisaged as arising from two sources:

- (1) an older Gondwanaland distribution: these ancestral forms, i.e. *Bathyraja*, *Dipturus*, probably had their origin in some other region. In the Southern Hemisphere at least they were distributed in the area of the Cape sulcus (Frakes & Crowell 1970), which was in existence until the end of the Jurassic. This would mean that these forms arose from the rhinobatid stock somewhat earlier than the proposed mid-Cretaceous origin for '*Raja*' proposed by White (1937);
- (2) a later north to south distribution, following the continental shelf and slope regions: these subgenera (*Raja*, *Amblyraja*, *Leucoraja*, *Rajella*) probably had their origin in the North Atlantic, and penetrated the southern African region in a series of waves, the most recent dating from the end of the last glacial period of the Pleistocene.

DISTRIBUTION

Skates are widely distributed in all oceans, where they occur from polar (Clark 1926; Nikolskii 1961; Andriashov 1966) to tropical latitudes (Fowler 1936; Bigelow & Schroeder 1962; Blache *et al.* 1970; Hulley 1972), but have their greatest species diversity in warm temperate and boreal latitudes (Bigelow & Schroeder 1953; Stehmann 1970). However, they have never been recorded from Micronesia, Polynesia, Hawaii and the tropical region of East Africa, around Zanzibar. Although found predominantly on the continental shelf and upper regions of the slope, recent investigations have shown that skates are present in archibenthal and abyssal regions (Garrick 1965; Forster 1965; Hulley 1970). Besides brief descriptions given by Barnard (1925), Norman (1935), Smith (1961) and Wallace (1967), no detailed account of the distribution of southern African Rajidae has been given, although Hulley (1966, 1969) has commented on the distribution of *Raja pullo punctata*, *R. clavata*, *R. alba* and *R. miraleatus*.

The limits of the southern African region have been variously defined (Barnard 1925; Knox 1960; Smith 1961; Day 1967; Penrith 1970) and appear

to depend largely on personal choice. For the purposes of this discussion, the southern African region, as defined by Barnard (1925) has been used; that is, the subcontinent south of the fifteenth parallel, extending from about Moçâmedes in southern Angola on the west coast, to north of the Zambezi River mouth in Moçambique on the east, and taken down to a depth of 1000 metres. The northern limits of this region on the west coast have been fairly well covered by research cruises of the *Mercator*, *Walther Herwig*, *Atlantide* and the Belgian South Atlantic Expedition, while the area north of Beira on the east coast has been covered during Cruise 8 of R.V. *Anton Bruun*.

The distribution of the dominant elements of the intertidal flora and fauna of South Africa has been summarized by Stephenson (1939, 1944, 1948), who, on the basis of surveys of rocky intertidal shores, recognized three faunal provinces with areas of overlap between them: the west coast, from the Orange River mouth to Cape Point; the south coast, from Cape Agulhas to Port Elizabeth; and the east coast, from Port St. Johns to northern Natal. In discussing the distribution of polychaete worms, Day (1967) considers that the west and south coasts are not distinct below the intertidal zone, and has pointed out that bottom temperatures at 100 metres (12° – 14°C) are uniform from Port Elizabeth to Lüderitzbucht. He recognizes four faunistic provinces in southern Africa:

- (1) the Moçambique–Madagascar province, dominated by tropical species: this reaches Lourenço Marques;
- (2) the Natal province, with tropical species, but also with fair numbers of endemics and Atlantic species; this reaches Bashee River;
- (3) the Cape and South West African province, dominated by endemics, but with a few tropical and several other components;
- (4) the Angola province, dominated by tropical West African species: this extends north of Cape Frio. Penrith & Kensley (1970*a*, *b*) suggest that the southern limit of this province may extend to between Lüderitzbucht and Walvis Bay, at least intertidally.

These faunal provinces allow for the greatest number of generalizations and, since certain of the boundaries remain speculative, may be expanded or contracted to suit the discussion of particular groups of organisms. Fishes, however, are unsuitable subjects on which to base conclusions regarding faunal distribution boundaries, owing to their mobility. In his discussion on the zoogeography of the fishes of the Indian Ocean, Cohen (1971) postulates that the 20°C isotherm is the most reliable parameter marking the boundary between tropical and temperate waters, and limits the tropical region of the east coast to Natal. Myers (1939) considers that the boundary of the tropical Indo-Pacific is best defined by the distribution of the genus *Scarus* (Pisces, Callyodontidae), which would mean that, as far as the ichthyofauna is concerned, the boundary of the tropical region may be further south, in the region of East London. Smith (1961) places the boundary of the Indo-West Pacific at Great Kei River mouth.

On the basis of distribution beyond the limits of the southern African region, the ichthyofauna has been divided into seven categories (Barnard 1925; M. M. Smith 1970): deep and mid-water species; cosmopolitan and circum-tropical species; Indo-Pacific species; Atlantic species, confined to the west coast; austral species; eastern Atlantic and Mediterranean species, which pass around Cape Point to various points on the east coast; and endemics. The distribution of these categories is intimately connected with hydrographic conditions (M. M. Smith 1970).

The known latitudinal and depth distributions of the 22 species of Rajidae, recorded from the southern African region, are shown in Figures 58, 59, while the frequency of occurrence is given in Table 3. The sampling data does not allow for comment on the relative abundance at various depths and hence the variation in depth distribution with latitude.

Of the species, 13 are endemic, 8 are known from the eastern Atlantic, and 1 species is also reported from Kerguelen. Of the endemics, *Cruriraja durbanensis*, *Raja dissimilis*, *R. ravidula* and *R. robertsi* are known only from the west coast; *Raja leopardus* and *R. caudaspinosa* are probably confined to the west coast, but have been recorded once from the east coast; *Cruriraja triangularis*, *Raja stenorhynchus*, *R. springeri* and *R. lanceostrata* are known only from the east coast; while *Cruriraja parcomaculata*, *Raja pullo punctata* and *R. wallacei* have been recorded both east and west of Cape Point. It is remarkable that no Indo-Pacific species of Rajidae are known from the southern African region, and a theory has been advanced to explain this phenomenon (see page 85).

Bottom temperatures, corrected to the nearest degree, at various depths throughout the southern African region have been taken from Rand (1965), Bang & Pearse (1970), Annual Reports of the Division of Sea Fisheries (1958, 1960, 1961, 1962, 1964) and unpublished station lists of R.V. *Meiring Naude*, and are summarized in Table 4. For latitudes 17°S to 34°S on the west coast, the range in bottom temperatures over a three-year period is given, while at other positions, temperatures from a single cruise tract are shown. It should be noted that the temperatures have mainly been taken from reversing bottles, so that the temperature at sounding depth is not available; the discrepancy varies from 5 metres inshore to 100 metres in depths over 300 metres. However, the records are only used to show major trends in temperature variation.

TABLE 3

Frequency of occurrence of southern African Rajidae. Rare/little known = 2-6 records; regularly present = 6-50 records; common = more than 50 records.

Single record only	Rare/little known	Regularly present	Common
<i>C. durbanensis</i>	<i>R. springeri</i>	<i>R. pullo punctata</i>	<i>R. alba</i>
<i>R. stenorhynchus</i>	<i>R. spinacidermis</i>	<i>R. confundens</i>	<i>R. miraleetus</i>
<i>R. lanceostrata</i>	<i>R. ravidula</i>	<i>C. parcomaculata</i>	<i>R. clavata</i>
<i>R. dissimilis</i>	<i>R. doutrei</i>	<i>C. triangularis</i>	<i>R. straeleni</i>
<i>R. robertsi</i>	<i>R. radiata</i>		<i>R. caudaspinosa</i>
	<i>B. smithii</i>		<i>R. leopardus</i>
			<i>R. wallacei</i>

TABLE 4

Bottom temperatures, corrected to the nearest degree, in the southern African region.

WEST COAST			WEST COAST (continued)		
Latitude	Depth (metres)	Temperature (°C)	Latitude	Depth (metres)	Temperature (°C)
9°S	30	23°	34°S	50-99	9-10°
	60	20°		100-149	10°
	100	15°		150-199	—
	300	12°		200-299	8-10°
	1 000	4°		300-800	5-8°
	50-99	13-15°		1 000	3°
17°S	100-149	13°	AGULHAS BANK	Latitude	Depth (metres)
	150-199	—		S	(°C)
	200-299	12°		Mossel Bay	30
	300-800	5-12°			16°
	1 000	3-4°			80
	50-99	12-14°			350
19°S	100-149	13-14°			1 000
	150-199	13-14°		S	5°
	200-299	12-13°		Knysna	50
	300-800	5-6°			10°
	1 000	4°		900	4°
	50-99	12-14°		1 000	4°
21°S	100-149	12-13°		Plettenberg Bay	100
	150-199	—			11-12°
	200-299	11-12°		200	12°
	300-800	4-11°		400	7°
	1 000	4°		1 000	4°
	50-99	11-13°		70	12°
23°S	100-149	10-13°		Port Elizabeth	200
	150-199	—			8°
	200-299	10-11°		800	5°
	300-800	5-10°		1 000	5°
	1 000	3°		50	12°
	50-99	10-12°		400	11°
25°S	100-149	10-12°		600	11°
	150-199	12°		1 000	5°
	200-299	10-11°		East London	50
	300-800	8-11°			12°
	1 000	3-4°		400	11°
	50-99	11°		600	11°
26,5°S	100-149	9-11°		1 000	5°
	150-199	10-11°		29°S	70
	200-299	9°			15°
	300-800	4-10°		1 000	5-7°
	1 000	3-4°		600	8°
	50-99	9-11°		1 000	5-6°
29°S	100-149	9-11°		32°S	50
	150-199	9-11°			21°
	200-299	—		800	8°
	300-800	10°		1 000	6°
	1 000	3°		150	16°
	50-99	—		1 000	5°
30,5°S	100-149	9-10°		28°S	300
	150-199	8-10°			12°
	200-299	8-9°		400	9-12°
	300-800	4-6°		400	11°
	1 000	3°		600	9°
	50-99	—		800	9°
32°S	100-149	9-10°		27°S	1 000
	150-199	8-9°			4°
	200-299	—		30	24°
	300-800	7-9°		400	10°
	1 000	3°		600	9°
	50-99	—		2 000	2°

Discussion

Classic zoogeography, which is concerned with the distribution of taxa in relation to physical and chemical parameters, rests solely on two foundations: the correct identification of the particular taxon on a world-wide basis, and extensive sampling, especially towards the limits of ranges, where specimens dwindle in numbers. Unfortunately, as far as rajids are concerned, both criteria have not been fully met. The new approach to rajid systematics is still in its infancy, and only the faunas of the western North Pacific (Ishiyama 1967), eastern North Atlantic (Stehmann 1970) and eastern South Atlantic (Hulley 1970) have been extensively examined. Furthermore, in the southern African region the majority of specimens have been taken by commercial trawlers, fishing between 250 and 900 metres, so that for the west coast at least there are few inshore records.

In certain instances, confusion of specimens and their localities rather than misidentification has taken place. This is obviously the case with Von Bonde & Swart's paper (1923), in which the type locality for *Cruriraja durbanensis* is given as $30^{\circ}10.00'S$, $14^{\circ}38.00'E$ in 859 metres, i.e. west coast, whereas the specific name indicates east coast, while the type localities for *Raja leopardus* and *R. caudaspinosa* are given as off Natal in 512 metres. Since the paratype of *Raja albalinea* (= *Raja caudaspinosa*) was also taken at 512 metres, but at $32^{\circ}3.00'S$, $16^{\circ}2.00'E$, and since these two species have not been recorded from Natal by Wallace (1967), it is considered that they are confined to the west coast.

While other factors such as salinity and bottom topography may play an important role in determining the distribution patterns of fishes (Gilchrist 1905; M. M. Smith 1970; Zoutendyk, personal communication), temperature has been considered the most determinate parameter (Ekman 1953; Hedgepeth 1957; Cohen 1971), and it is within this context that the distribution of southern African Rajidae will be considered. The effect of temperature can be twofold (Penrith 1970): it can act directly on the species concerned, or act in an indirect manner in limiting other organisms, which make a particular habitat more suitable. The ecology of the southern African Rajidae is still too little known to estimate the relative importance of direct and indirect influence of temperature.

Although no fish family is endemic to the southern African region, the degree of endemism at the species level in this region appears to be somewhat higher than in the Mediterranean or Galapagos Islands (Tortonese 1963; Rosenblatt & Walker 1963), and has been estimated at 31.5% (Barnard 1925). A lower value of 25.4% has been estimated by M. M. Smith (1970: 5), but she considers that 'true endemics' cannot be considered to come from deeper than 200 metres, as 'it is merely a matter of time and opportunity before they are found in other parts of the oceans'. There is no doubt, at least among elasmobranchs (Hulley 1971) that this is true, where the number of endemics is being constantly reduced with further systematic work. However, the estimated values approximate to that given by Day (1967) for polychaetes (36%). The percentage endemism varies from family to family; in some the value may be as high as

70% (Scyliorhinidae: Barnard 1925) and 100% (Clinidae: Penrith 1970). Stehmann (1970) indicates that of 22 species of Rajidae represented in the eastern North Atlantic 11 (50%) are endemic, and it would seem, therefore, that the value of 59.1% for the southern African rajid fauna is reasonable. There are no endemic genera or subgenera in the southern African region. All are represented in the eastern North Atlantic. Not only this, but the specific composition of the southern African rajid fauna shows a closer affinity with this region (Hulley 1970).

Day (1967) and Penrith (1970) have pointed out that the Cape/South West African province is dominated by endemics, and this is true of rajids, where 46.2% are confined to the west coast, while only 32.2% are entirely east coast in distribution. However, *Cruriraja durbanensis*, *Raja stenorhynchus*, *R. lanceostrata*, *R. dissimilis* and *R. roberti* are only known from their type localities. I consider their distribution too imperfectly known to be discussed further here.

Only one species, *Raja miraletus* (Fig. 59), shows discontinuous distribution in the southern African region, as defined. This species has been recorded from the Mediterranean (Clark 1926) and extends southwards along the north-west African and West African coasts, being recorded from Morocco (Clark 1926), Cape Bojador (Murray & Hjort 1912), Rio de Oro, Cape Blanc to Cape Verde (Pellegrin 1914), Senegal (Cadenat 1950) and from Cape Lopez in Gabon to Baie les Tigres in Angola (Fowler 1936; Poll 1951; Krefft 1968a). The southernmost record for the species at 18°30'S, 11°27'E was taken by FFS *Walther Herwig* (Hulley 1970). It is absent from regions further south, but is recorded in False Bay and extends northwards along the east coast to Richard's Bay (Wallace 1967).

While depth distribution records (Fig. 58) indicate that the species may occur down to 440 metres, Poll (1951) points out that *Raja miraletus* is essentially a shallow-water species, most abundant between 50 and 150 metres, where temperatures vary between 24.1°C and 12.7°C. From Table 4 it can be seen that for depths up to 200 metres on the west coast, a bottom temperature of 13°C or above is maintained as far south as about 19°S, but that from about 21°S to 34°S, the minimum temperature at 200 metres is lower, although at shallower depths may be between 12°C and 14°C as far south as about 23°S. This would suggest that this dominant member of the tropical West African fauna has a lower limiting temperature of about 13°C, and that its most southerly record (18°30'S) might mark the boundary zone from tropical West African to cold west coast fauna.

From False Bay to Durban, *Raja miraletus* is commonly taken in depths less than 100 metres, where temperatures vary seasonally (Bang, personal communication) between 9°C and 14°C. Although the present data allows for no prediction of onshore and offshore seasonal migrations of this species over the Agulhas Bank, it appears that the limiting temperature for *Raja miraletus* in this region may be slightly lower than on the west coast, i.e. there may be physiological differences between West African and South African specimens. It

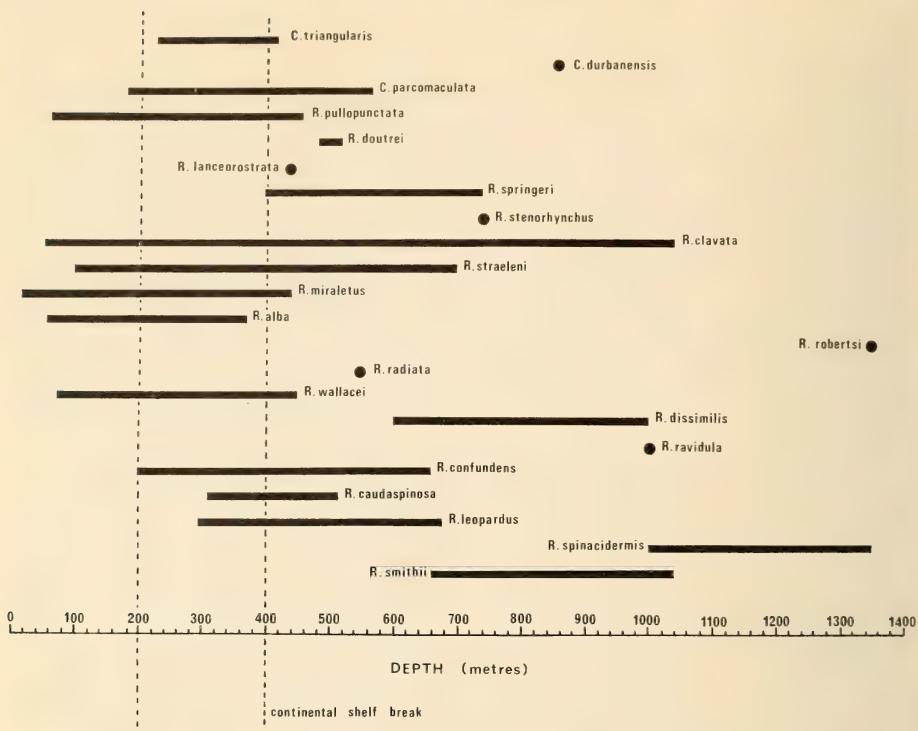


Fig. 58. Depth distribution ranges of southern African Rajidae.

should be pointed out that there are some morphological details (Hulley 1969) which would substantiate the distinction of a South African subspecies. Although the most northerly record on the east coast is at Richard's Bay, bottom temperatures indicate that the species could inhabit waters further to the north (Table 4).

Two other species found in tropical West African waters also penetrate the southern African region. *Raja straeleni* is common between 20°N and 15°S (Blache *et al.* 1970). Poll (1951) points out that this species, which inhabits colder waters than *Raja miraletus*, has regularly been taken in depths greater than 200 metres in this region, but may be found in shallower depths in more southerly latitudes. Temperatures at 200 metres in the tropical region vary from 11.6°C to 15.75°C (Poll 1951). From Table 4 it would appear that for depths greater than 200 metres, a lower limiting temperature of about 12°C occurs in the region between 21°S and 23°S. The most southerly record of this species at 22°03'S, 13°12'E (Fig. 59) would substantiate this temperature limit. Again it can be seen that inshore temperatures remain higher from 23°S to about 29°S, which would mean that the species may be expected to be found at shallower depths in this region.

Raja doutrei, the other tropical West African species, has been taken off the

coast of Senegal (Cadenat 1960) at a depth of 450–600 metres, where bottom temperatures are in the order of 6°–10°C (Ingham 1970). This would mean that *Raja doutrei* would be capable of extending as far south as Cape Point, although its most southerly record to date is only 27°S.

Therefore, on the basis of rajid distribution alone, the southern boundary of the tropical West African fauna cannot be accurately fixed, since the temperature dependency of each species varies considerably. However, the distribution pattern of the only inshore species, *Raja miraletus*, would support the recognition of a boundary zone between 18°S and 20°S, as proposed by Penrith & Kensley (1970a, b) for rocky intertidal shores.

The phenomenon of bipolar (antitropical) distribution is well reported in the Rajidae (Hubbs 1952; Bigelow & Schroeder 1953; Hulley 1966; Krefft 1968b; Stehmann 1970), where certain species exhibit equatorial discontinuity in latitudinal distribution. Four species in the southern African region show this type of distribution pattern, which in this instance should be termed antitropical rather than true bipolarity. *Raja clavata* and *R. alba* are known from the eastern North Atlantic and Mediterranean (Clark 1926; Stehmann 1970), and extend southwards to about 20°N (Cape Blanc). They are not recorded over the tropical West African region, but reappear in the waters off South West Africa, from where they extend around Cape Point to Barra Falsa in Moçambique (Wallace 1967), southern Madagascar and Mauritius (Hulley 1966: fig. 8). In order to allow for gene flow from north to south and vice versa, equatorial submergence of these species probably takes place, so that it is possible that they will be discovered in deeper waters in tropical latitudes along the West African coast. The records of both species east and west of Cape Point (Fig. 59) support the idea of suitable, uniform temperatures for the west, south and east coasts at depths greater than 100 metres. It should be noted that the temperature range at 100 metres, 12°–14°C, given by Day (1967) appears to be somewhat high, for although there are seasonal variations, the temperatures east and west of Cape Point at 100 metres vary from 9°C to 10°C (Table 4).

It is interesting to note (Fig. 59) that, in the South Atlantic, *Raja clavata* appears to have a northern limit at about 23°S, and is replaced by the closely allied species, *R. straeleni*, over the area 22°S to 15°S, in the southern African region. Direct temperature dependence seems an insufficient explanation for this, and it is probable that competition between the species plays an important role in limiting the spread of *Raja clavata* towards the end of its possible temperature range at that depth, since both species have a similar depth distribution range (Fig. 58).

The other species exhibiting antitropical distribution patterns, *Raja spinacidermis* and *R. radiata*, also show an east/west distribution in the North Atlantic (Stehmann 1970). In the southern African region, *Raja radiata* is known from a single record (Fig. 59) and *Raja spinacidermis* only from deep water off Cape Point (Hulley 1970), so that it is impossible to comment further on their distribution.

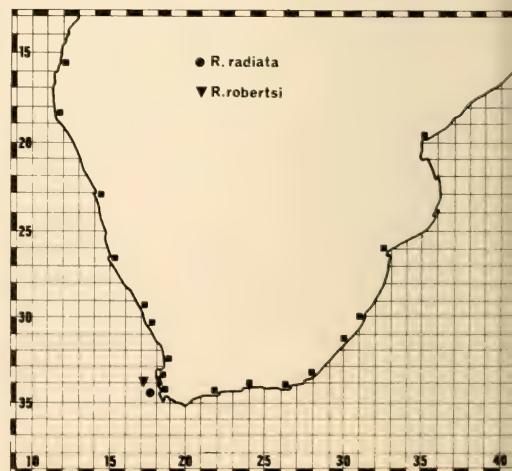
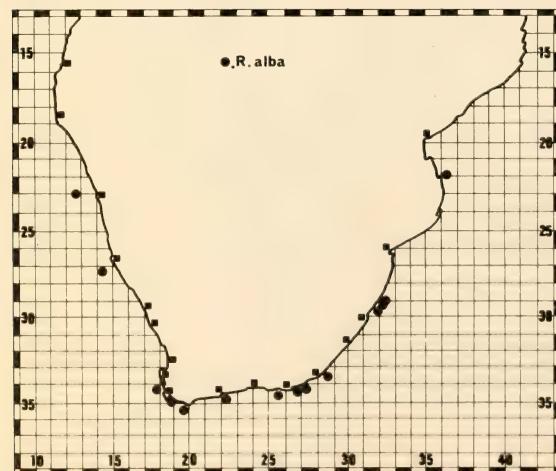
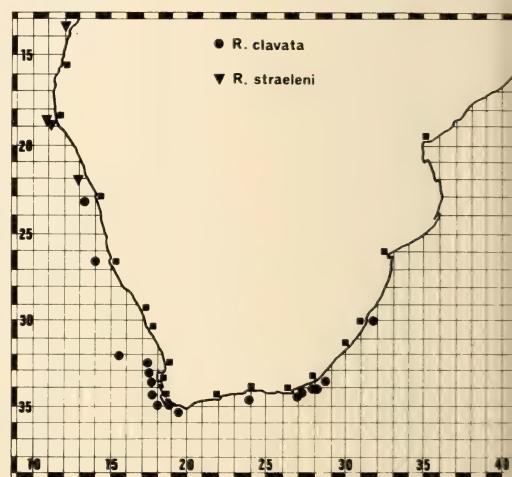
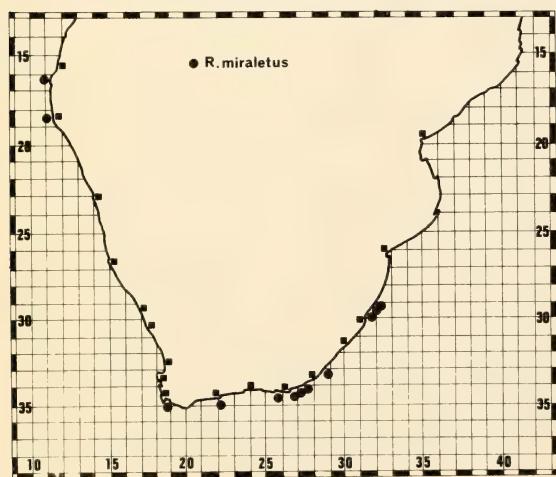
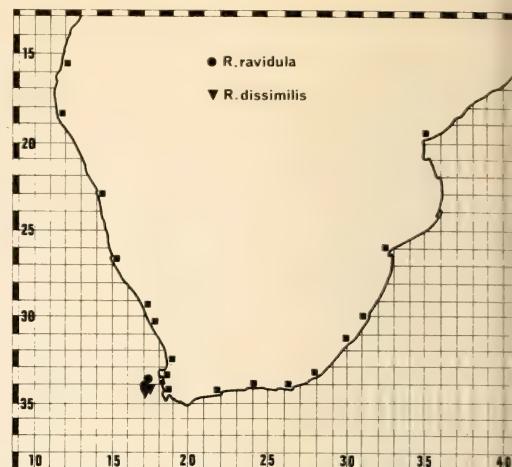
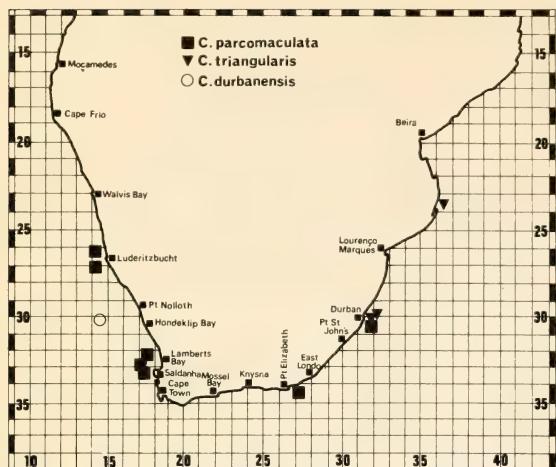


Fig. 59. Distribution of Rajidae and 'Crurirajidae in the southern African region. Open symbols indicate doubtful records.

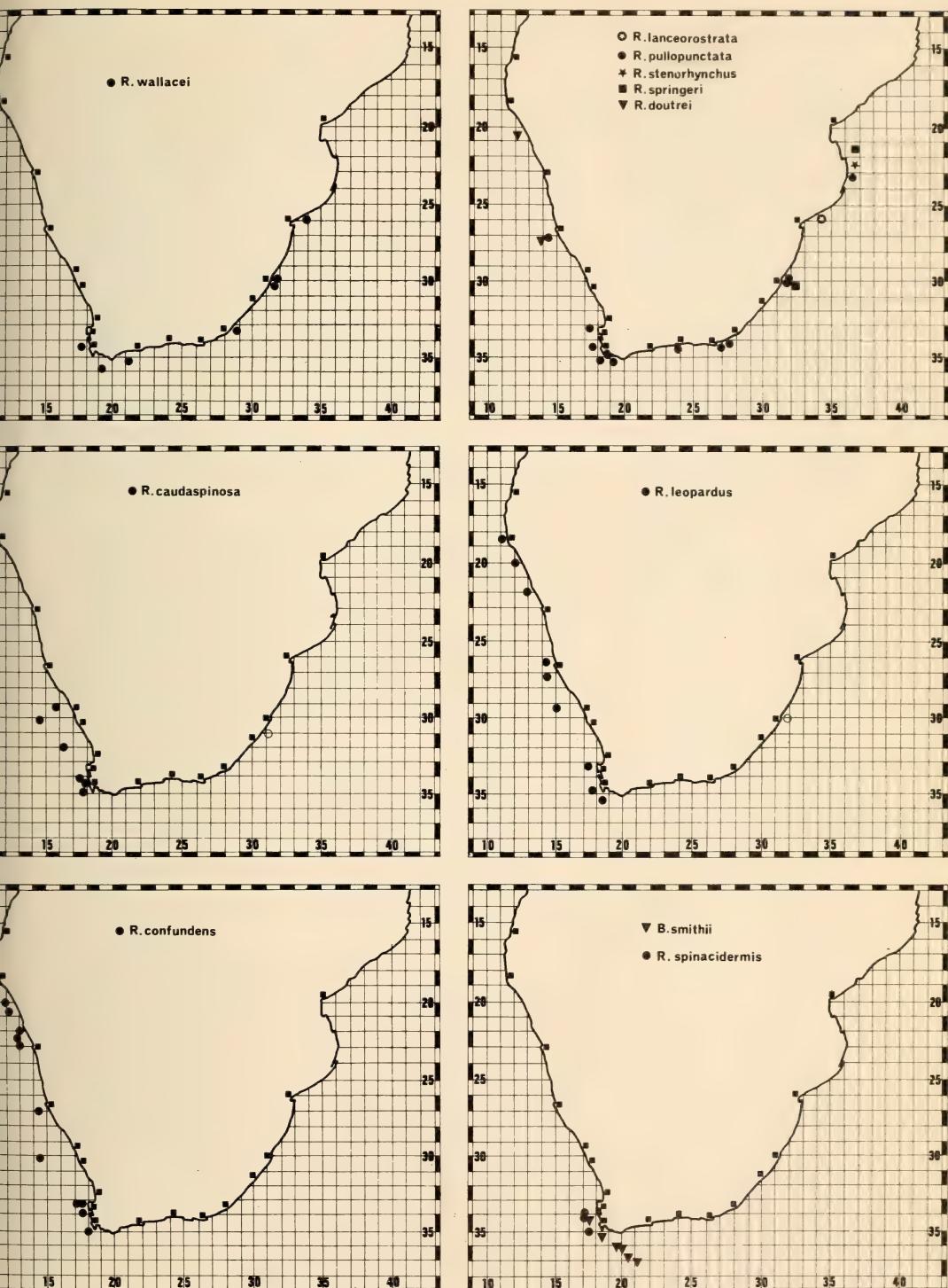
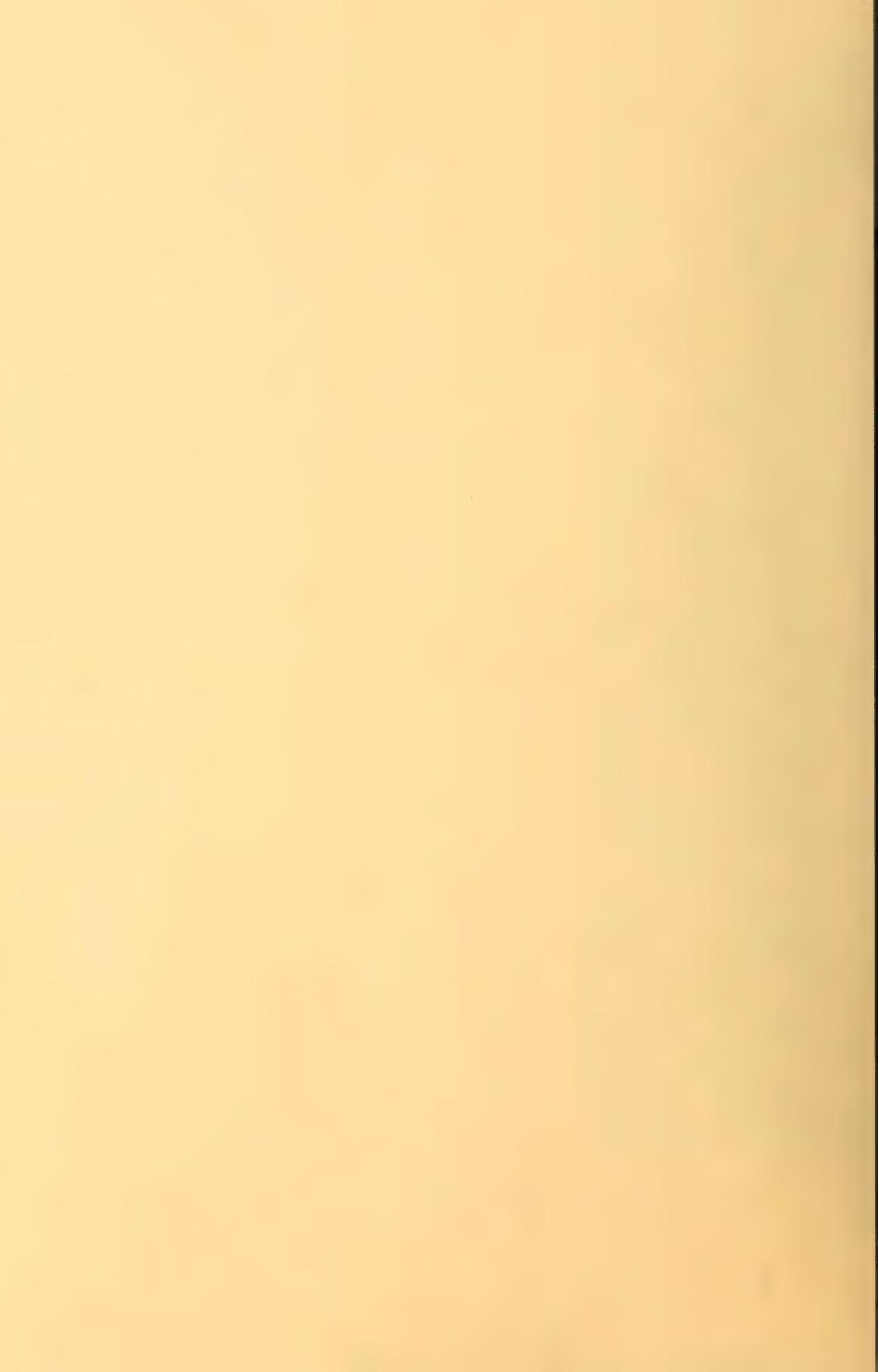


Fig. 59. (continued)



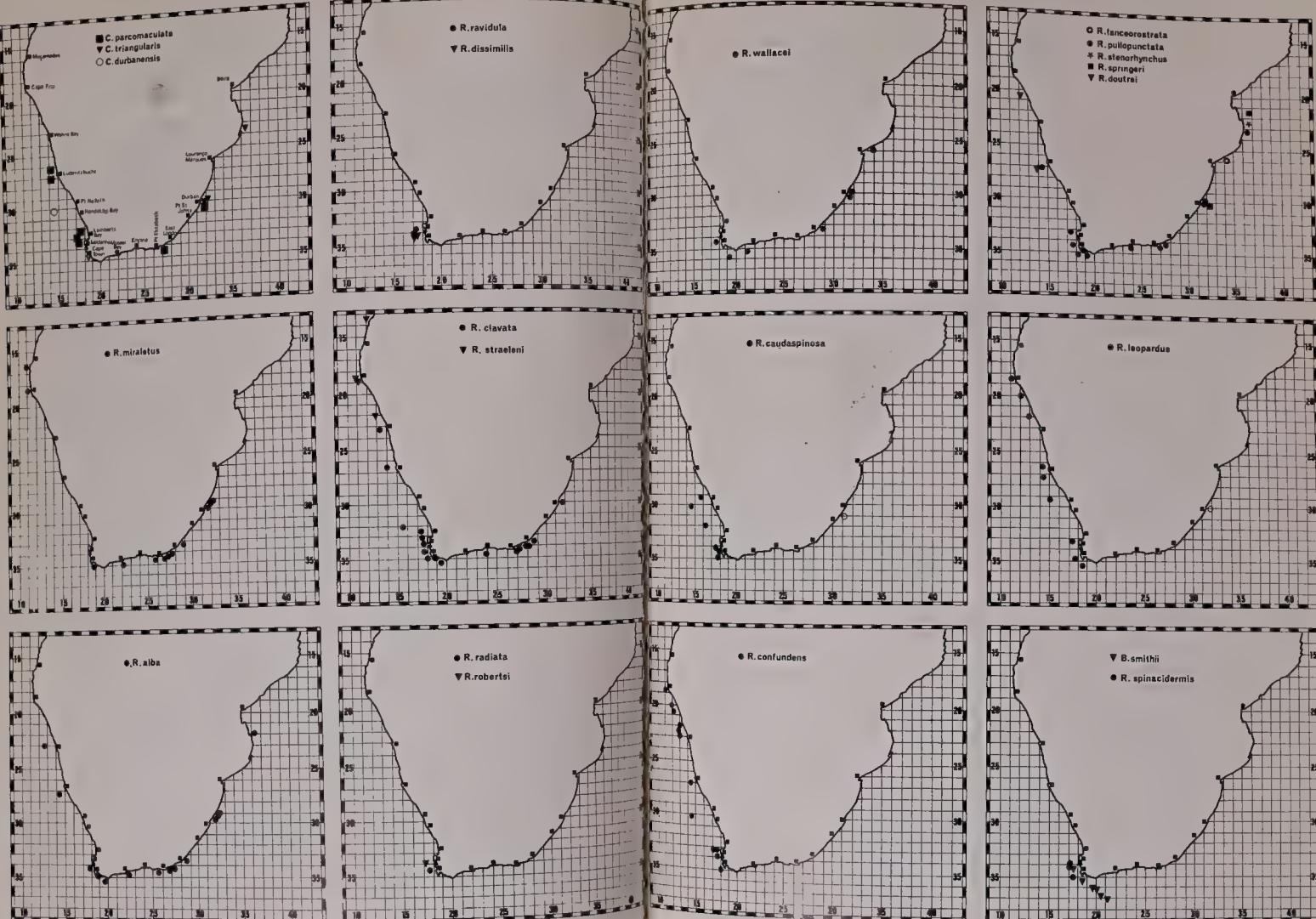


Fig. 59. Distribution of Rajidae and Crurirajidae in the southern African region. Open symbols indicate doubtful records.

Fig. 59. (continued)

While the west/south/east coast distribution of the endemic species, *Cruriraja parcomaculata*, *Raja pulloponctata* and *R. wallacei* (Fig. 59), may be explained in terms of uniformity of temperatures at depths greater than 100 metres, the distribution of the east coast endemics, *Cruriraja triangularis* and *Raja springeri* (Fig. 59), and the west coast endemics, *Raja caudaspinosa* and *R. leopardus* (Fig. 59), are more difficult to account for in terms of temperature dependence. However, both *Cruriraja triangularis* and *Raja springeri* are known only from the northern limits of the east coast (Durban to Barra Falsa) in 230–420 metres and 400–740 metres respectively, where minimum temperatures are higher than further south. *Raja leopardus* and *R. caudaspinosa* are apparently confined to the west coast, west of Cape Point, despite the fact that their type localities have been given as off Durban (Von Bonde & Swart 1923). M. M. Smith (1970) reports an entirely west coast distribution for certain South African fishes, although it appears that this is inexplicable in terms of temperature dependence.

Raja confundens (Fig. 59) is not now regarded as a southern African endemic species, and has been reported at 2°09'N, 9°27'E in 260–650 metres (Krefft 1968a; Hulley 1970). Because of this range, it is probable that the species will be taken east of Cape Point in the future.

Bathyraja smithii (Fig. 59) has been recorded from Kerguelen and from the slope regions of the western edge of the Agulhas Bank, where its depth distribution (Fig. 58) indicates an association with the Antarctic Intermediate Water mass. This water mass is characterized by a salinity minimum core (34.33‰) at 600–1 500 metres and temperatures of 4°–5°C (Orren 1963; Shannon 1966), and is sandwiched between the warm Deep Water and Central Water, which forms the source for the Benguela Current. Since the Antarctic Intermediate Water extends northwards in the Indian Ocean at 200–300 metres deeper than in the southern Atlantic (Orren 1963), it is probable that *Bathyraja smithii* is not confined to the western slope regions, and will be taken in depths of 800–1 800 metres off the Natal coast.

In conclusion, it must be pointed out that as far as the southern African rajid fauna is concerned, distribution patterns are complex and do not follow precisely the faunistic provinces as limited by Day (1967), although these limits were based on distribution data only to 200 metres. There is no doubt that tropical West African species extend into this region, but the southern limit of this fauna is indistinct, although inshore species indicate some boundary zone in the region between 18°S and 22°S. Furthermore, while several species seem to be confined to the northern regions of the east coast and indicate another boundary zone in the region south of Durban, i.e. a Natal province, the majority of the species are widely distributed throughout the whole southern African region. There is also some evidence that the direct influence of temperature may not be the only limiting factor.

SUMMARY

The structure of the pelvic girdle, neurocranium and the predorsal caudal vertebral count are described for southern African Rajoidea, as are the structures of the claspers of 17 species of Rajidae, *Rhinobatos annulatus*, *Myliobatis cervus* and *Anacanthobatis marmoratus*, and the North American species *Cruriraja rugosa* and *Anacanthobatis americanus*. A discussion of clasper terminology is included.

On the basis of the above, the southern African Rajoidea have been grouped into the following families, genera and subgenera:

Family **Rajidae**

Genus *Bathyraja* Ishiyama, 1968

species: *Bathyraja smithii* (Müller & Henle, 1841)

Genus *Raja* Linnaeus, 1758

subgenus *Raja* Linnaeus, 1758

species: *R. miraleetus* Linnaeus, 1758; *R. clavata* Linnaeus, 1758; *R. straeleni* Poll, 1951

subgenus *Dipturus* Rafinesque, 1810

species: *R. doutei* Cadenat, 1960; *R. pullofornata* Smith, 1964; *R. lanceorstrata* Wallace, 1967; *R. springeri* Wallace, 1967; *R. stenorhynchus* Wallace, 1967

subgenus *Rostroraja* subgen. nov.

species: *R. alba* Lacépède, 1803

subgenus *Amblyraja* Malm, 1877

species: *R. radiata* Donovan, 1808; *R. robertsi* Hulley, 1970

subgenus *Leucoraja* Malm, 1877

species: *R. wallacei* Hulley, 1970

subgenus *Rajella* Stehmann, 1970

species: *R. caudaspinosa* Von Bonde & Swart, 1923; *R. leopardus* Von Bonde & Swart, 1923; *R. confundens* Hulley, 1970; *R. dissimilis* Hulley, 1970; *R. ravidula* Hulley, 1970

Family **Crurirajidae** fam. nov.

Genus *Cruriraja* Bigelow & Schroeder, 1948

species: *C. durbanensis* (Von Bonde & Swart, 1923); *C. parcomaculata* (Von Bonde & Swart, 1923); *C. triangularis* Smith, 1964

Family **Anacanthobatidae**

Genus *Anacanthobatis* Von Bonde & Swart, 1923

species: *A. marmoratus* Von Bonde & Swart, 1923

Genus *Springeria* Bigelow & Schroeder, 1951

species: *S. ori* Wallace, 1967

The subgenus *Rostroraja* is described as new and includes the single species, *Raja alba*, while a new family, *Crurirajidae*, is defined to include all species of the genus *Cruriraja*. The family *Anacanthobatidae* is diphyletic and, for the moment, it is considered that the genus *Anacanthobatis* is monotypic. The North American species *Anacanthobatis americanus* should be referred to a new genus.

The phyletic interrelationships of the suborder *Rajoidea*, based on these morphological details, are discussed and an evolutionary pattern, different from that of Stehmann (1970), is proposed. On this evidence, and on the evidence presented by world-wide zoogeographical distribution, a theory as to the origin of the southern African rajid fauna is advanced. The effectiveness of a warm-water barrier zone off the East African coast and its prevention of either a northward migration of temperate rajid species or a southern invasion by Indo-Pacific species appears to be significant and is discussed in relation to the origin of the rajid fauna.

The distribution of the southern African Rajidae is discussed with particular reference to temperature parameters, so far as the limited data will allow.

ACKNOWLEDGEMENTS

I am deeply indebted to Dr N. A. H. Millard, formerly of the Department of Zoology, University of Cape Town, for helpful criticism and guidance throughout this work, and to Mr S. X. Kannemeyer, of the South African Museum, for his assistance during all phases; to Dr G. Krefft, Institut für Seefischerei, Hamburg, for many suggestions and valuable criticism and for much useful material; to Dr M. Stehmann, Institut für Seefischerei, for many inspiring discussions and recommendations; and to Prof. R. Ishiyama, Tokyo University of Fisheries, for his advice.

I am grateful to the late Prof. J. L. B. Smith and Mrs M. M. Smith, J. L. B. Smith Institute of Ichthyology, Grahamstown; to Mr J. H. Wallace, Oceanographic Research Institute, Durban; and to the Directors of the British Museum (Natural History), the Institut für Seefischerei, the Institut Royal des Sciences Naturelles de Belgique and the Muséum National d'Histoire Naturelle, for access to their collections.

I wish to express my thanks to Mr Stewart S. Springer, formerly of the National Museum of Natural History, Washington, not only for many X-ray photographs, but also for the donation of specimens of *Anacanthobatis americanus* and *Cruriraja rugosa*; to Dr F. M. Mombeck, Institut für Seefischerei, for the collection of the *Walther Herwig* specimens; and especially to Miss Christa Lübben, Institut für Seefischerei, for photographs and X-ray plates of *Raja straeleni* and *R. spinacidermis*, and for her kind hospitality during my stay in Hamburg.

My thanks are also due to the following individuals, either for placing specimens in existing collections at my disposal or for help with X-ray photography: Miss P. Verity, Nuffield Institute for Comparative Medicine; Drs P. H.

Greenwood, N. B. Marshall and Mr A. Wheeler, British Museum (Natural History); Dr W. Templeman, Fisheries Research Board of Canada, St. Johns; Dr J. P. Gosse, Institut Royal des Sciences Naturelles de Belgique, Brussels; Dr M. Poll, Musée Royal d'Afrique Centrale, Tervuren; Dr M. L. Bauchot, Muséum National d'Histoire Naturelle, Paris; Messrs M. J. Holden and C. N. Humphries, Fisheries Laboratory, Lowestoft; and Drs H. Wormald and R. Hindle, Durban.

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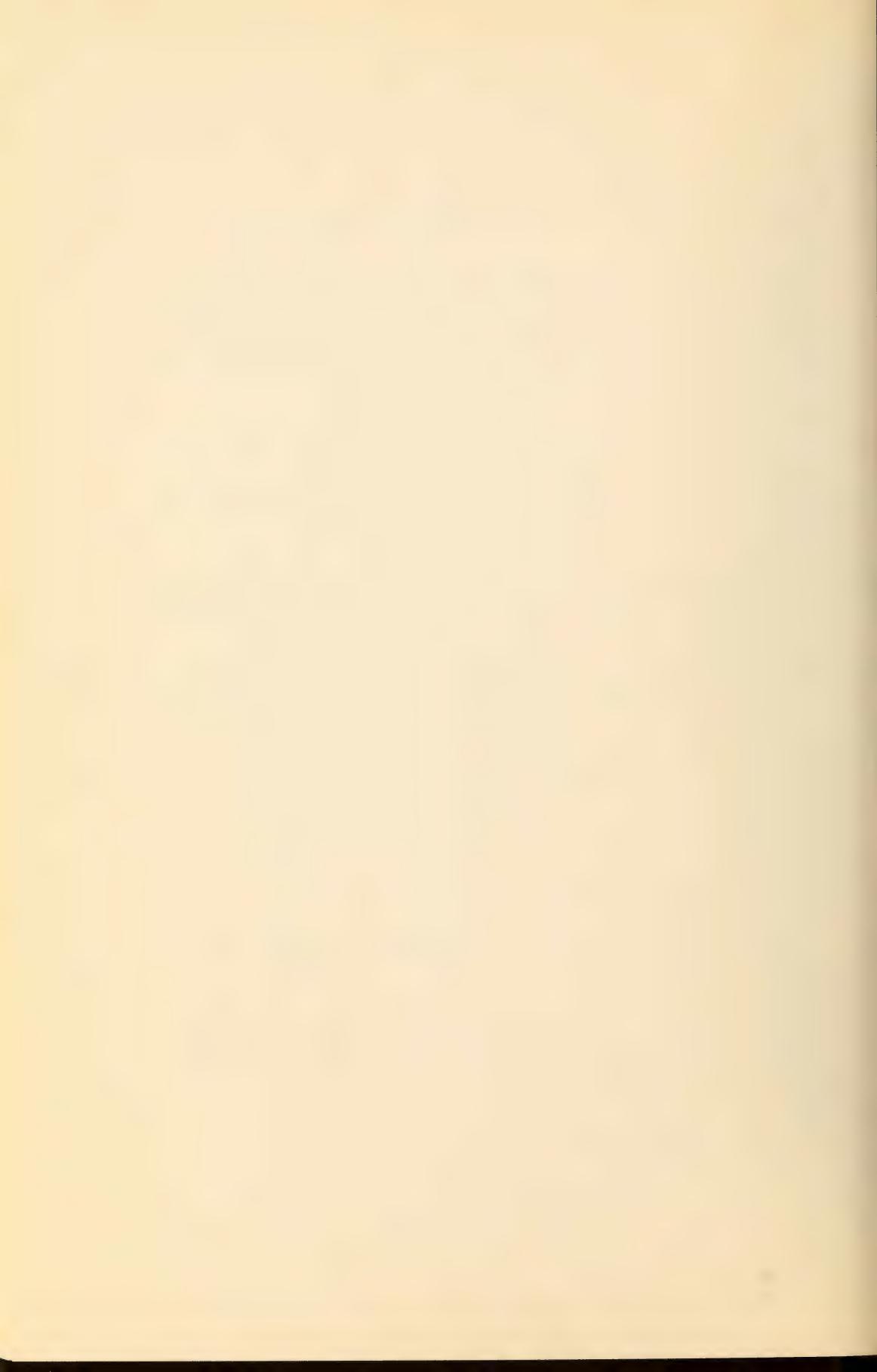
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Example

Scalaria coronata Lamarck, 1816: pl. 45¹, figs 5 *a*, *b*; Liste: 11. Turton, 1932: 80.





P. A. Hulley

THE ORIGIN, INTERRELATIONSHIPS
AND DISTRIBUTION OF SOUTHERN
AFRICAN RAJIDAE (CHONDRICHTHYES,
BATOIDEI)

VOLUME 60 PART 2

NOVEMBER 1972

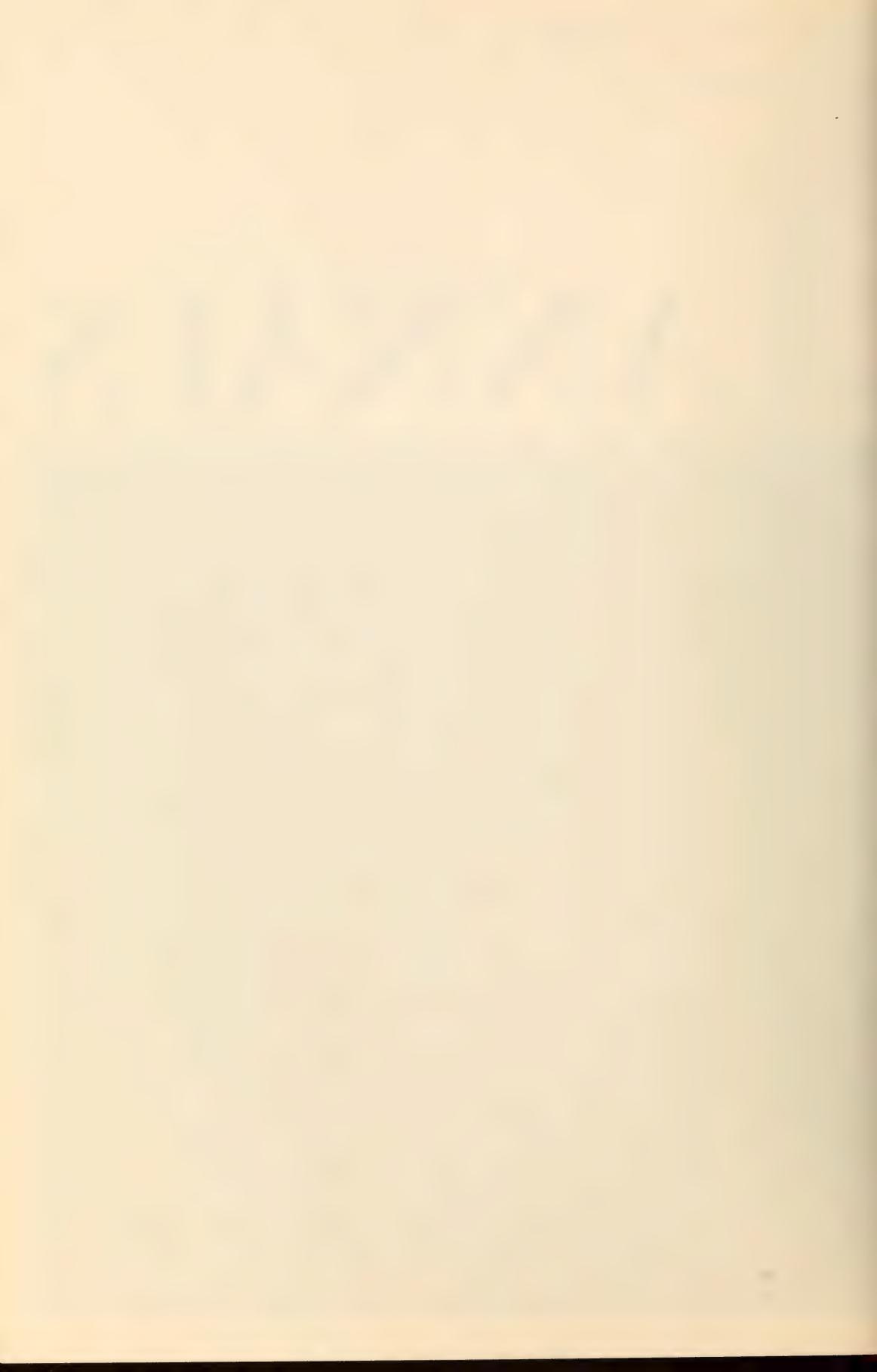
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ANNALS OF THE SOUTH AFRICAN MUSEUM
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Volume **60** Band
November **1972** November
Part **2** Deel



REDESCRIPTION OF *PANDAKA SILVANA*
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By
M. J. PENRITH & MARY-LOUISE PENRITH

Cape Town Kaapstad

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Verkrybaar van die Suid-Afrikaanse Museum, Posbus 61, Kaapstad

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1, 2(1, 3, 5, 7-8), 3(1-2, 5, t.-p.i.), 5(1-2, 5, 7-9),
6(1, t.-p.i.), 7(1-3), 8, 9(1-2), 10(1),
11(1-2, 5, 7, t.-p.i.), 24(2), 27, 31(1-3), 33

Price of this part/Prys van hierdie deel

R1,00

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1972

ISBN 0 949940 16 X

Printed in South Africa by
The Rustica Press, Pty., Ltd.
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

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M. J. PENRITH & MARY-LOUISE PENRITH
State Museum, Windhoek

(With 1 figure)

[MS. accepted 1 June 1972]

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INTRODUCTION

During a check of the type collections of the South African Museum, the syntypes of *Gobius silvanus* Barnard, described in 1943 from the upper reaches of the Knysna estuary, were found. We discovered that this species had been omitted from both Smith's revisions of southern African gobies (1959, 1960) and from Jubb's (1967) account of the freshwater fishes of southern Africa.

On examination the specimens were found to agree closely with the genus *Pandaka* Herre, 1927, described originally for two species from the Philippine Islands. The species included in *Pandaka* are minute gobies with a low number of dorsal and anal rays; about 20–22 rows of large ctenoid scales on the body; the nape and head naked; a feeble pelvic fraenum; two rows of teeth in each jaw, the inner row of the upper jaw minute, the inner row of the lower jaw equal to or only very slightly smaller than the outer row; and the tongue rounded. *Gobius silvanus* agrees with *Pandaka* in all these respects as well as in the general colour pattern, with the one exception that it has two predorsal scales. Smith (1959) described *Pandaka minuta* from Ibo and Wamizi Islands in Moçambique. This southern African species also differs from the Philippine species of *Pandaka* in having predorsal scales, given as 3–4 in Smith's description, although in the three paratypes of *Pandaka minuta* we have examined we could find only two predorsal scale pockets.

The species *Gobius silvanus* Barnard is therefore placed in the genus *Pandaka* Herre. We have designated the female specimen illustrated (Fig. 1) as the lectotype, the remainder of the syntype series being paralectotypes. *Pandaka silvana* is redescribed below. The dorsal and anal ray counts differ from those

given in the original description because the last ray in each fin, which is split to the base, is here counted as one element, while Barnard apparently counted it as two. Unless otherwise stated, all lengths referred to are standard length.

DESCRIPTION

Pandaka silvana (Barnard, 1943)

Gobius silvanus Barnard, 1943: 258

Material

1 specimen, female, 18 mm, lectotype; 22 specimens (14 males, 8 females), 13.3–18.0 mm, paralectotypes; all from Knysna Lagoon, Republic of South Africa. All specimens in the South African Museum (S.A.M. 26208, lectotype, S.A.M. 19355, paralectotypes), with the exception of a single stained paralectotype retained by the authors and in the collection of the State Museum, Windhoek (S.M. P. 561).

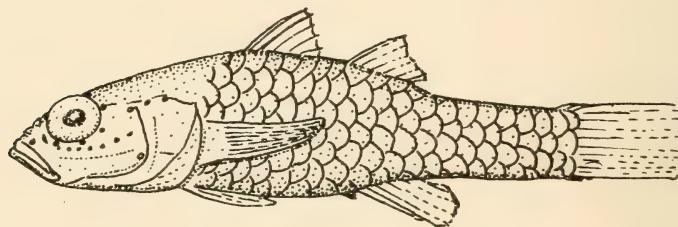


FIG. 1. *Pandaka silvana* (Barnard), lectotype, female, 18.0 mm.

Description

D VI+I 6–7. A I 6. P 16. Dorsal fins well separated, first dorsal not elevated in either sex. Ventral fins united, fraenum at base very poorly developed. Caudal fin truncate. Branchiostegal rays: 6.

Maximum body depth 22–31 per cent of standard length. Body covered with large ctenoid scales, 20–21 longitudinally, seven transversely at vent. Nape, head, and breast naked.

Head 29–35 per cent of standard length, slightly depressed, naked; nape naked except for two large predorsal scales. Snout rounded; lower jaw slightly projecting. Mouth moderate, jaw reaching first third of eye. Eye large rounded, 8–11 per cent of standard length. Anterior and posterior nostrils tubular. The arrangement on the head of pores and sensory papillae as far as could be determined from the minute, rather poorly preserved specimens is shown in Figure 1. A dentary pore, not able to be shown, is present at the lower angle of the jaw. The main rows of papillae are: a row along lower edge of preopercle to tip and continued along under lower jaw to chin; two horizontal rows on

cheek from subocular pore, upper row of fewer and larger papillae than lower row, which consists of numerous small papillae; a vertical row down opercle behind preopercular flange, and a horizontal row running back across opercle from lower third of vertical row; three short horizontal series between hind margin of eye and upper posterior corner of opercle.

Teeth in two rows in each jaw, those of lower jaw almost equal in inner and outer rows, the inner row of upper jaw minute, very much smaller than outer row. Tongue rounded to subtruncate. Gill openings restricted, not extending beyond pectoral base. No vomerine teeth.

Males with genital papilla narrow, acutely conical, and elongate; female genital papilla short and broadly conical; several females ovigerous.

Colour

Faint darker marks along middle of flank; very faded owing to long preservation.

DISCUSSION

Pandaka silvana was compared with three paratypes of *Pandaka minuta* from Moçambique. *P. silvana* is apparently a larger species (all the ovigerous females were over 16 mm, and most of the specimens were 16–18 mm standard length, while none of the ten specimens of *P. minuta* exceeded 16 mm total length). *P. minuta* has 22 scales in the lateral series (20–21 in *P. silvana*), and a very dark mark at the pectoral base, apparently not present in *P. silvana*, although the latter species has a faint mark at the pectoral base which may merely have faded. *P. silvana* has the teeth slightly smaller than *P. minuta*, and the scales are more markedly striated in *P. silvana*. The genital papilla is situated relatively slightly further back in *P. minuta*; in *P. minuta* the distance genital papilla to caudal base is markedly less than the distance genital papilla to eye, while in *P. silvana* these distances are about equal. *P. silvana* differs from the Philippine species *P. pusilla* Herre and *P. pygmaea* Herre in the possession of predorsal scales and further from *P. pusilla* in the lack of an elevated first dorsal fin in the male.

Pandaka silvana is so far known only from the type locality. It appears to be unique in the genus *Pandaka* as a temperate estuarine species, the other species being tropical and marine. As the fresh waters of the Cape Province are well known it does not seem likely that *Pandaka silvana* extends into the freshwater headwaters of the Knysna estuary.

SUMMARY

Gobius silvanus Barnard, described in 1943 from the Knysna Lagoon, and subsequently ignored in literature on South African gobies, is placed in the genus *Pandaka* Herre, redescribed, and a lectotype selected from the syntypic series and figured.

ACKNOWLEDGEMENTS

We are indebted to Dr T. H. Barry, Director of the South African Museum, to Dr P. A. Hulley, South African Museum, and to Mrs M. M. Smith, Director of the J. L. B. Smith Institute of Ichthyology, for lending us specimens for examination, and to Dr D. Cohen of the Ichthyological Laboratory, Washington, for generous assistance with literature.

We acknowledge the permission of the Secretary for National Education to publish this paper.

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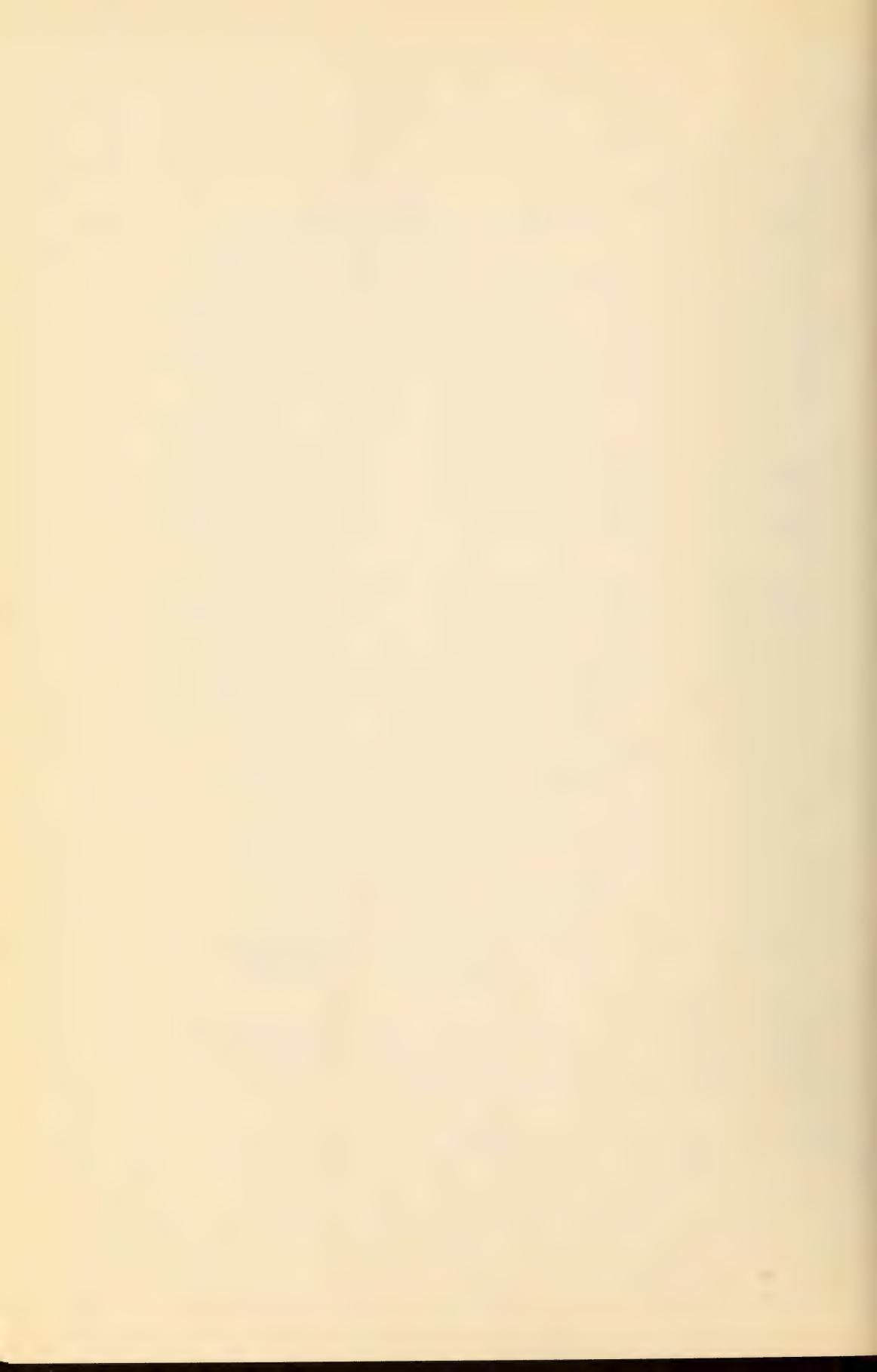
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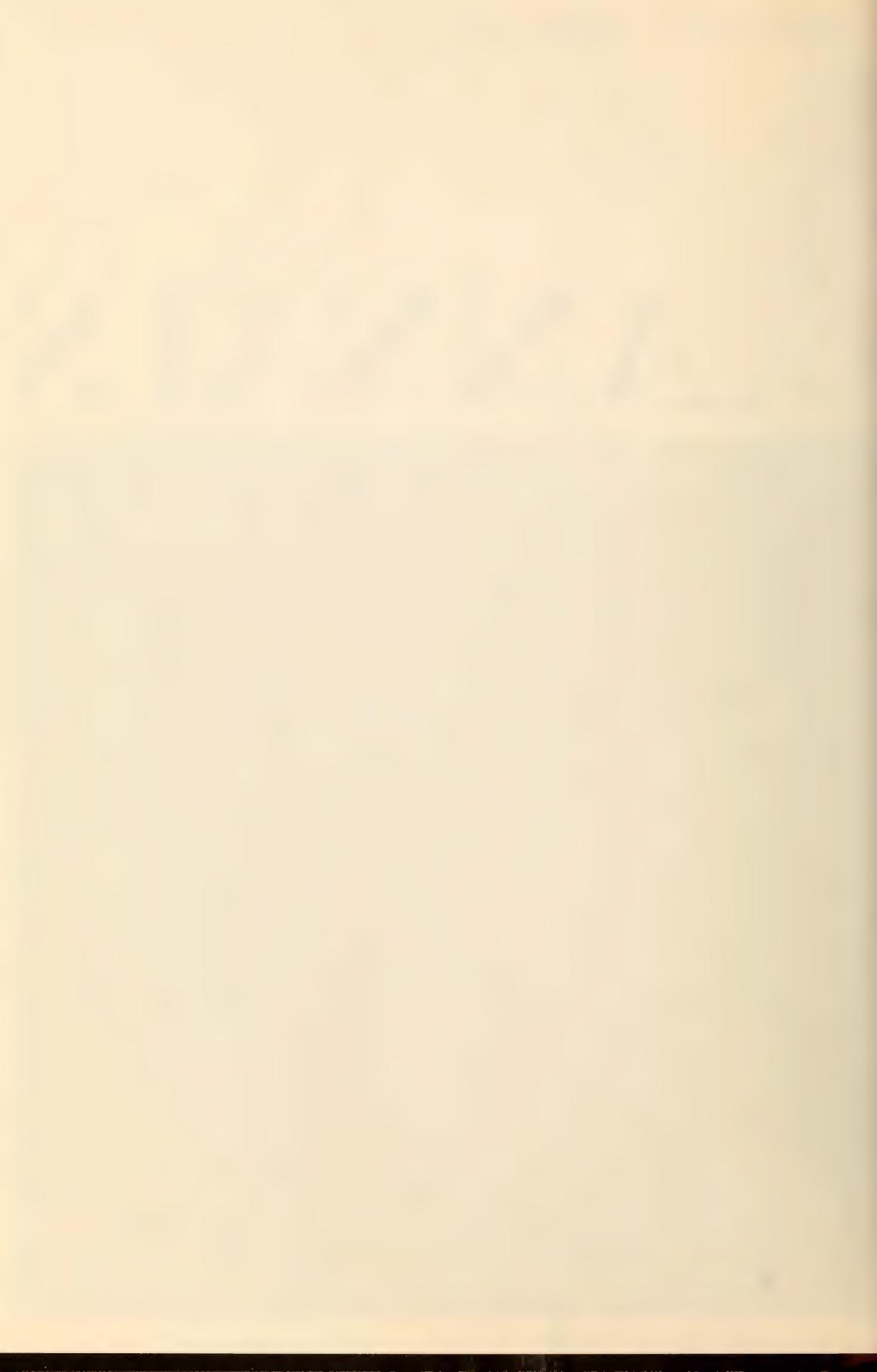
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Price of this part/Prys van hierdie deel

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1972

ISBN 0 949940 17 8

Printed in South Africa by
The Rustica Press, Pty., Ltd,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

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(With 8 figures)

[MS. accepted 12 June 1972]

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INTRODUCTION

Since my revision (Hesse 1969) of the Mydaidae of southern Africa some interesting new genera and species of this family, from various parts of South West Africa and the Namib Desert, have been submitted to me for identification and others have been very kindly presented to the South African Museum.

As South West Africa is faunistically one of the most interesting territories in southern Africa, with its southern arid parts, its semi-desert east passing into the Kalahari, its western coastal Namib Desert, its central grassland savannah and broken thorn bush, and its north and north-eastern subtropical and tropical enclave, the description of new and strange species from such different environments is a necessary obligation in a faunistic survey of the territory.

The mydaid fauna is comparatively rare anywhere in southern Africa, if not in Africa, and the acquisition and descriptions of these various new forms from this part of the subcontinent, as a sort of addendum to my revision of the family, become necessary.

Up to date 12 species of Mydaidae have been described from South West Africa. These, listed more or less in taxonomic order and with the dates of description in brackets, are:

Eremohaplomydas desertorum Bequaert (1959)

Lachnocorynus kochi Hesse (1969)

Afroleptomydas pseudolanipes Bequaert (1963)

Afroleptomydas pulverulentus Hesse (1969)

Afroleptomydas pseudo-opacus Bequaert (1963)

Afroleptomydas (Crossoptoprosopus) kaokoensis Hesse (1969)

- Afroleptomydas (Crossoprosopus) rudebecki* (Bequaert) (1959 and 1969)
Namadytes vansonii Hesse (1969)
Namadytes prozeskyi Hesse (1969)
Notosyllegomydas brincki (Bequaert) (1959 and 1969)
Nothomydas gariepinus Hesse (1969)
Cephalocerodes eremobius Hesse (1969)

In this paper 16 new species, including 3 new genera, are described. The total number of known species from the territory is now 28, divided among 10 genera.

More organized and intensive collecting in this vast territory is bound to increase this number of genera and species considerably in future.

DESCRIPTIONS

Subfamily Syllegomydinae

Tribe Syllegomydinae

Genus AFROLEPTOMYDAS Bequaert

Afroleptomydas lindneri n.sp.

A single ♂ specimen, among the Mydaidae from South West Africa submitted by Professor E. Lindner of the Staatliches Museum für Naturkunde in Stuttgart, and labelled as 'Gen. nov. pr. ? Nomoneura Bezzi' is obviously a new species of *Afroleptomydas*, which I have the pleasure in naming for Professor Lindner. It has no relationship with *Nomoneura*, and is characterized as follows:

Body with the vertex of head on each side infused with dark reddish brown; antennae dark blackish brown, joint 1 also slightly infused reddish brown; proboscis black, its base more brownish; the following parts pale reddish brown: humeral tubercles, notopleural part, an abbreviated submedial streak on each side of mesonotum ending before middle, postalar calli to an obscure extent, anterior and posterior parts of mesopleuron, the pteropleuron, an infusion on metapleural parts, area below and behind halteres, sides of tergite 1, base laterally of 2 (the last three more yellowish), extreme sides of 2–5 to an obscure extent, apical parts of lobes of tergite 9, sternites 8 and 9, hypopygial structures (especially apical parts of processes of sternite 9, and the aedeagal apparatus); venter also mainly reddish brown, paler near base; hind margins of tergites 2–6 and very narrowly of 7 whitish, narrower across sides; bullae reddish brown; hind margins of sternites on extreme sides also pallid; legs mainly reddish brown, the femora darkened above.

Integument of central part of frons shining; that of antennae dull; proboscis mainly shining; thorax above dull; pleurae subshining, with microscopic areolar microsculpture; metanotum mainly dull, posteriorly subshining, also

with indications of fine areolar microsculpture; abdomen above and below more or less shining, more so towards apex, finely setiferously punctured, the genital parts, including sternite 8 duller, finely microscopically microsculptured; integument of legs also dull, with very fine areolar microsculpture.

Vestiture with the hairs on head moderately long and dense, snow white, those on each side just behind antennae and on clypeus the densest, directed downwards, those on upper part of frons laterally, on vertex and upper part of occiput directed more upwards, the occipital part fairly densely snow-white-haired all round, the upper occipital part also with distinct and conspicuous brownish postvertical spines; sides of frons and sides of occipital part behind eye-margins with dense white tomentum; hairs on the following parts snow white: humeral tubercles, dense ones along notopleural part, anteriorly on the two submedial mesonotal streaks, across base of mesonotum, the finer shorter and sparser ones on the submedial pale mesonotal streaks, very short and sparse ones along the central mesonotal streak, longish ones across hind part of mesopleuron, those on pteropleuron, metapleural part, on sides of metanotum, dense ones on sides of tergite 1, as well as less dense longish ones on tergite 1 discally, longish ones on sides in basal half of 2, much shorter and sparser ones on extreme sides of 3, fine and short ones on genital segments, sparse and longish ones medially on sternite 2, a tuft of longish hairs on each side of prosternum, shorter ones basally and anteriorly on front coxae, sparse ones laterally on middle coxae, sparse ones on metasternum, and a tuft of longish hairs laterally and basally on hind coxae; short decumbent hairs in setiferous punctures on tergites 2–5 dark or blackened, those discally and laterally on 6 and 7 gleaming more sericeous in certain lights; the short ones on extreme sides of tergites 4–7 paler, more sericeous yellowish; short backwardly-directed hairs in setiferous punctures on sides of venter also dark, those along middle appearing paler, and those on sternites 7 and 8 distinctly more sericeous yellowish; hairs on legs very short, seta-like, denser on femora above, sparser on sides and below, appearing dark in certain lights and silvery gleaming in others, those on tibiae even shorter, gleaming pale sericeous yellowish and whitish.

Head broader than thorax; eyes large, very convex; interocular space on vertex comparatively narrow, only a little less than a third width of head broader than space below head (as 16:11), the inner margins of eyes widest apart opposite antennae where the distance is wider than interocular space, the margins thus slightly converging to vertex and more so towards head below; vertex itself distinctly sunk in; clypeus only slightly prominent; proboscis (cf. Fig. 1, top left) about 2.48 mm long, the stem slightly broadened and compressed to labella in side view, the labellar lobes ploughshare- or hoof-shaped, sharply pointed apically, the heel-part rounded, striated transversely and covered with fine spinules, the rest of stem very sparsely spinulated; palps subequal in length to first antennal joint; antennae (cf. Fig. 1, top left) close together, long, nearly or quite as long as mesonotum plus scutellum, joint 1 thickened, subspindle-shaped, about twice length of joint 2, the latter a little

broader than long, with a crown of short blackish brown hairs, joint 3 rod-like, a little less than 4 times length of 1 and 2 combined, longer than club, not demarcately thickened apically, obscurely transversely and shallowly ringed, except in apical part, the club elongate, broadest at about middle, from there to base gradually narrowing and with only a slight neck-like base, apicalwards at first slightly constricted then again widening subapically, the apical sensory part sloping up conically to tubercle.

Wings relatively broad, not projecting beyond abdomen, infuscated smoky brownish in more than anterior half, more or less to end of second submarginal cell, to basal part of first posterior cell at level of apex of discoidal cell, to faintly along posterior vein of third posterior cell, to apical part of latter and posteriorly and across to apex of anal cell, being darkest in middle part of wings in greater parts of marginal, first submarginal and first basal cells and along veins in hinder half; greater part of first posterior cell, the apical part, broad hind border, broad axillary lobe and middle parts of anal, third posterior and discoidal cells being clearer; veins brownish; second submarginal cell with a well-developed appendix; first posterior cell much or sharply narrowed apically, shortly stalked on costal margin; discoidal cell shortly stalked apically; hind border of wings comparatively broad; axillary cell markedly broad, with distinct flattened cilia along hind margin at broadest part and minute ones from there to its apex; alula well developed, broad, lobe-like; halteres pale yellowish brown, but more than posterior half of broadened apical part black.

Legs moderately long; hind femora much thickened, subspindle-shaped, thickest a little beyond middle, armed below with a double row of strong, backwardly-directed, blackish brown spines on tubercles, beginning a little before middle, with about 7 in outer row and 7 in inner one (one of the hind femora in the specimen is damaged and tibiae of both missing); front and middle tibiae, apart from their apical spicules, with about 3–5 dark spicules along posterior lower aspect and a few much shorter ones along anterior upper part, the middle ones also with 3–5 longer ones along anterior ventral part; anterior tibiae below with a ventral streak of dense, brush-like, short hairs beginning near base and more evident in apical half; front and middle tarsi about, or a little less than, half length of corresponding tibiae; claws well developed, yellowish brown, darker at bent-down apices; pulvilli well developed.

Hypopygium (cf. Fig. 1, bottom left) with the lateral lobes of tergite 9 angularly pointed; sternite 9 roundly prominent posteriorly, slightly laterally compressed apically, its processes in side view gradually narrowed apically and the apices directed upwards, in dorsal view strap-like, slightly narrowed to blunt and rounded apex; aedeagal apparatus rather elongate, the anterior or dorsal epimere long, extending much beyond the two phallic tubes which are also comparatively long.

From the ♂ holotype in the Stuttgart Museum.

Length of body: about 14.5 mm

Length of wing: about 11.5 mm

Distribution

South West Africa: Guinas (? 29/9/54) (No regional locality is given and no collector's name). From the handwriting the collector probably was Herr F. Gaerdes of Okahandja.

This species is to be placed in the *westermanni*-section of *Afroleptomydas* in which the hind femora are distinctly thickened or incrassate and the wings in a number of ♂♂ are infuscated. Characters such as the presence of delimited bare streaks on mesonotum, white hairs on mesonotum, the short dark hairs on the abdomen above, the type of wing-infuscation, the apically-narrowed and stalked first posterior cell, the relatively dark legs, etc., however exclude it from any of the subsidiary sections of the *westermanni*-group of species.

CROSSOPROSOPUS Hesse subgenus of AFROLEPTOMYDAS

All the other species of *Afroleptomydas*, collected in South West Africa and submitted to me for identification and described in this paper, belong to the subgenus *Crossoprosopus*, defined by me in 1969. This subgenus is apparently well represented in the territory.

Afroleptomydas (Crossoprosopus) angolensis n.sp.

Three ♂♂ from Angola, collected by Dr Brown, though not from South West Africa, are described below because the locality from which they come is just north of the Kunene River and similar environmentally to that of north-western South West Africa in which this species might also occur. This new species is very near *tuliensis* Hesse from Rhodesia and is characterized as follows:

Body on the whole much darkened above, dark brown to blackish brown; antennal joints 1 and 2, about basal $\frac{2}{3}$ of joint 3, and greater part of club, except black base and sometimes the slightly darkened subapical part of latter, orange yellowish; clypeus yellowish; head below pale yellowish brown; proboscis black, pale yellowish brown below; humeral tubercles, sides of thorax above, postalar calli, medial basal part of mesonotum in front of scutellum, scutellum, sides of metanotum to a variable extent, pteropleural and metapleural parts in front of halteres to a variable extent, and hypopleural part pale yellowish brown; sides and also broad hind margin of tergite 1 also pale yellowish brown, the middle of the hind margin inclining to be more yellowish; abdomen brown to dark brown or even blackish brown; hind margins of tergites 2–7 ivory yellowish or yellowish white, becoming progressively narrower, the last 2 being much narrower than the very broad ones across tergites 2–4, the sides of tergites sometimes more yellowish brown or brown to a variable extent, especially on 2–5, contrasting with the darker discal dorsum which latter tends to appear darker, more patch-like basally dorsally; bullae rather large, bean-shaped, the broad anterior border mainly shining black, the median anterior discal part just behind the black anterior border tending to be orange brownish

to a variable extent, the space between bullae much broader than transverse length of bullae; venter either mainly dark or to a variable extent yellowish brown, especially on sternites 1-5 (or 6), the hind margins of sternites 1-6 however broadly whitish, especially on sides; genitalia mainly yellowish brown, sometimes dark reddish brown; legs yellowish brown to reddish brown, the femora above darker brownish, the bases of hind ones more yellowish, the knees and bases of tibiae also paler, more yellowish, more than basal halves of hind tibiae above, especially when viewed from behind, also more yellowish, only the apical part appearing darker, the front and middle coxae dark brownish, the hind ones paler, more yellowish, the tarsi more yellowish, the apices of the joints below darkened, and claw joint also blackish towards apex.

Integument of central raised part of frons, clypeus, and head below smooth and shining; that of thorax above dull, leathery; metanotum dull, leathery; greater part of pleurae dull, the outer part of anterior spiracle, and sutural parts, anterior part of pteropleuron, and sclerites below wing-bases however shining; abdomen above mainly dull, somewhat shining across extreme bases on sides of tergites 3-5, with fine, separated, not very dense, setiferous puncturation, slightly denser on sides of tergites 2 and 3 and absent from ring-like hind margins of tergites, those on 6 and 7 more 'nadelrissig'; venter also with separated setiferous puncturation, absent from broad transverse basal parts of sternites and from broadish shining hind margins, and also from extreme sides of sternites, the last two sternites with indications of transverse striae or rugae, especially on sides; legs mainly dull.

Vestiture not very long; that on vertex and head in front dense and white, shorter and less dense on occiput, with dense, greyish white tomentum on sides of frons and on occiput; hairs on thorax above mainly white, those discally sometimes with a slight sericeous yellowish tint, dense and longer on sides and medially basally in front of scutellum, the short decumbent ones on disc arranged in more or less 2 broadish submedial streaks and a narrow, linear, central one along the middle, all these longitudinal streaks, as well as hairy sides, separated by more or less bare streaks, the hairy streaks being on streaks of tomentum; hairs on metanotum also white, the integument of metanotum itself with slight greyish tomentum; pleurae with fine greyish, not very dense, tomentum, the posterior margin of mesopleuron, the pteropleuron, metapleural part in front of spiracle, and metasternal part with white hairs, not much longer than those on sides of thorax above; tergite 1 also with dense, longish, white hairs on sides; base of tergite 2 especially sides, with similar longish white hairs; extreme base laterally of tergite 3 also with some long white hairs; fine, short, backwardly-directed hairs in punctures on dorsum of abdomen gleaming slightly sericeous yellowish, the integument of tergites however covered with greyish white to faintly yellowish white tomentum; venter with some longish white hairs basally on sternite 2; the backwardly decumbent ones on greater part of venter slightly longer than short ones on dorsum and also with a slight sericeous yellowish tint; hairs on hypopygium not very dense, sericeous

white to faintly sericeous yellowish; hairs on legs comparatively short and not dense, mainly gleaming sericeous white, denser and longer on coxae, the femora below bare; spines on hind femora below and spicules on tibiae whitish, those on tarsi tending to be more faintly yellowish white to yellowish.

Head broader than thorax; vertex sunk in; interocular space on vertex about as wide as distance of central frontal ridge between vertex and base of antennae, wider than space below head; yellowish white postvertical spines present; clypeus convex; antennae longer than mesonotum, about 3.9–4.1 mm, joint 1 slightly thickened, about twice as long as 2; joint 3 elongate, about 3.5–3.7 times combined length of 1 and 2, longer than club, with a little less than its apical fourth thickened; club itself (excluding articulation between it and joint 3) distinctly shorter than joint 3, elongate pyriform, broadest at about apical fourth, beyond that sloping up or narrowing to the transverse crater-like terminal tubercle, the base of club constricted neck-like; proboscis about 2.8 mm long, only a little longer than vertical length of eye; palps small, but distinct.

Wings greyish hyaline, with a very faint indication of faint yellowish borders to the veins in apical part beyond apex of first basal cell; veins near base and costal vein yellowish, in rest of wings brown or dark brown; first posterior cell broadly open on costal vein; second submarginal cell with or without a short appendix at base; halteres yellowish white, the knobs infused with brown above to a variable extent.

Legs moderately long; hind femora thickened, spindle-shaped, with a double row of pallid spines (7–10 in both rows) on tubercles below, beginning a little distance away from base; front and middle tibiae slightly curved, without any distinct spicules (excepting apical spurs) on front ones, but with 2 rows of widely separated pallid spicules on middle tibiae; hind ones with granules below and with an outer row of pallid spicules on granules in apical half; basal joint of hind tarsi subequal to or only a little longer than claw-joint; pulvilli just falling short of apices of claws.

Hypopygium (cf. Fig. 2, top left) with the lobes of tergite 9 slightly angularly produced apically; sternite 9 conical, medially incised apically, its processes in side view slightly S-curved, in dorsal and ventral views hollowed, narrowed towards apex and bluntly pointed; aedeagal apparatus with the dorsal epimere longer than the phallic tubes.

From a ♂ holotype and 2 ♂ paratypes in the South African Museum.

Length of body: about 19–20.5 mm

Length of wing: about 12.5–14 mm

Distribution

Angola: Mocâmedes District: 42 km south of São Nicolau (H. D. Brown, 16/4/1971).

From the Rhodesian species *tuliensis* Hesse, nearest to it, it differs in being slightly larger, with comparatively longer, more slender abdomen, distinctly longer antennae, joint 3 and club being proportionally longer, longer labella

of proboscis, less dense, sparser and slightly shorter vestiture, relatively broader anal cell, its posterior vein more sinuous, distinctly longer slender part (side view) of processes of sternite 9, their apices blunter in dorsal view, and larger sternite 9.

Afroleptomydas (Crossoprosopus) ovamboensis n.sp.

A somewhat damaged rather small ♂ specimen from Ovamboland in the collections before me, and belonging to a new species, is characterized as follows:

Body mainly dark; head, including clypeus, black; proboscis very dark blackish brown; antennae dark yellowish brown, the first joint, thickened apical part of joint 3, base and apex of club darker, more black, the broad middle part of club orange yellowish; humeral tubercles yellow; thorax above, scutellum, pleurae and metanotum black; sclerites below wing-bases brownish yellow; abdomen mainly brownish, the dorsal discal basal parts of the tergites darker, more blackish brown, more so on tergites 1–6, the sides basally of tergites 1–3 distinctly more yellow and to a lesser extent also those of 4–7, the hind margins of 2–8 broadly pale yellowish white, those of 7 and 8 narrower, and that of tergite 1 the narrowest; venter more yellowish brown, the hind margins of sternites 1–7 also broadly pale yellowish white; bullae shining black, widely separated; hypopygium pale yellowish brown, the anal lobes more yellowish; legs mainly yellowish, the coxae dark or black, more or less apical half of hind femora darker above, more brown, and claw-joint of tarsi also more brown.

Integument of medial part of frons, clypeus, head below and proboscis shining; that of thorax above dull, leathery; scutellum subshining; metanotum dull, with indications of some transverse grooves on sides; pleurae mainly dull, the propleural part and sutural part of sternopleuron somewhat shining; abdomen discally on dark discal patches dull, the sides of basal segments and sides of rest of tergites up to 6 more or less shining, the tergites with setiferous puncturation and tending to be striated on sides towards hinder parts; processes of sternite 9 and aedeagus shining; venter shining, with sternites 7 and 8 somewhat transversely striate; legs subshining, with fine setiferous puncturation lodging the hairs, the outer bases of front and middle femora, and to a finer and lesser extent the tibiae transversely striate, the granulation on hind tibiae below rather feebly developed and not dense.

Vestiture fairly dense, but not very long, mainly snow or sericeous white; that on head in front dense, snow white; that on head below sparser; that on sides of thorax above, postalar calli, and basally in front of scutellum dense and snow white; the backwardly-decumbent, shorter ones on disc gleaming more sericeous yellowish, arranged more or less in streaks, a narrow central streak and 2 broader submedial ones, with a bare sublateral streak on each side which becomes entirely bare in hinder half; hairs on metanotum denser on sides; pleurae mainly bare, with fine greyish tomentum, with very sparse white

hairs across hind margin of mesopleuron, sparse on pteropleuron, and denser in front of halteres; abdomen with dense, longish, white hairs on tergites 1 and 2, especially on sides, some longish ones also on sides basally of 3 and 4, with the other short, decumbent hairs in fine punctures on tergites gleaming slightly sericeous yellowish in certain lights, sparser on tergite 7, also comparatively sparse on hypopygium; hairs on venter slightly longer than on dorsum, mainly white, longer on sternites 1-4; hairs on legs gleaming mainly sericeous white, not very long, except on coxae where they are also denser, those on front and middle femora above also longer and denser than on rest of legs, slightly sparser and shorter on hind femora above, the shorter ones on all the tibiae gleaming slightly more sericeous yellowish; spines on hind femora below and spicules on tibiae and tarsi pale yellowish white; tomentum on sides of head in front greyish white, rather narrowly confined along eye-margins, that on occiput also greyish white, more extensive; fine greyish tomentum on disc of thorax more or less confined to hair streaks; that on metanotum slightly denser than that on entire pleurae; the fine greyish tomentum on tergites 1-6 visible in certain lights, even on black basal discal patches on 3-6.

Head much broader than thorax; vertex sunk in; no distinct postvertical spines detectable; interocular space on vertex only a little broader than space on head below; antennae subequal in length to mesonotum plus scutellum, joint 1 only slightly thickened, about $2\frac{1}{3}$ times length of 2, and with only a few hairs, joint 3 nearly or about 3 times length of 1 and 2 combined, thickened in a little less than apical $\frac{1}{3}$, the club elongate pyriform, slightly longer than joint 3, narrowed neck-like at base, broadest at about or a little less than apical $\frac{1}{3}$, its apical sensory area more rapidly narrowed on inner than outer part to crater-like prominence; proboscis short, only a little longer than club of antennae, very much shorter than vertical length of eyes, only about 1.24 mm long; palps small, but distinct, with yellowish hairs apically; buccal cavity below projecting rather prominently ledge-like.

Wings comparatively short, clear hyaline, with a faint whitish tint in certain lights; veins mainly yellowish, becoming more yellowish brown in apical and hinder parts of wings; first posterior cell narrowly opening (or sessile) on costal margin; second submarginal cell with a short appendix; discoidal cell stalked apically; halteres whitish.

Legs with the front and middle femora unarmed below; hind femora moderately thickened, spindle-shaped, armed below with a double row of spines on tubercles, about 8 in outer row and 9 in inner one, the latter beginning before the outer one from near base; front and middle tibiae slightly curved, the pale spicules on middle ones more developed, longer; hind tibiae with distinct spicules on granules, only present along a little more than outer apical third, the rest in the row minute or small, the granules below the hind tibiae on the whole poorly developed; basal joint of hind tarsi subequal in length to claw-joint.

Hypopygium (cf. Fig. 2 top middle) with the lateral lobes of tergite 9 rather

angularly pointed; sternite 9 bluntly rounded apically, medially dorsally and apically with the usual incision, the dorsal processes of the sternite rather long, in side view rather slender, slightly upcurved, in dorsal view slightly curved outwards in apical part and sharply pointed apically; aedeagal apparatus with the central and dorsal shoe-horn-shaped epimere rather long, projecting much beyond the two phallic tubes.

From a single ♂ holotype in the South African Museum.

Length of body: about 13.5 mm

Length of wing: about 8 mm

Distribution

South West Africa: Ovamboland: 35 km north-west of Oshakati (H. D. Brown, 21/4/1970).

Superficially this species resembles the ♂ of *vansoni* Hesse in the nature of the vestiture, short proboscis and yellow legs, but differs in its entirely dark clypeus, longer and less thickened antennal clubs, more slender legs, a first posterior cell which opens more narrowly on costal margin, comparatively longer processes of sternite 9, and distinctly longer epimere of aedeagal apparatus.

From ♂♂ of certain forms or varieties of *mauricei* Beq. it may at once be distinguished by its longer hairs, denser hairs on head in front, slightly longer hairs on rest of body and legs, comparatively much shorter antennae, very much shorter proboscis, darker clypeus, paler legs, comparatively longer and more slender processes of sternite 9, and comparatively longer and more slender epimere.

Afroleptomydas (Crossoprosopus) nigrescens n.sp.

An almost entirely black-bodied ♂ and a ♀, which I take to be the same species, in the collections from South West Africa before me, represents a new species which is near *mauricei* Beq.

The ♂ specimen is characterized as follows:

Body almost entirely dark blackish brown to black; clypeus reddish brown; antennae brown, joints 1 and 2 dark blackish brown, greater part of clubs, excepting brownish, neck-like, basal part and apical sensory area, orange yellow; proboscis reddish brown, its labella slightly darker; humeral tubercles pale yellowish and area around them more reddish brown; rest of thorax, excepting dark brownish postalar calli and sclerites below wing-bases, entirely dark; abdomen very dark blackish brown to black, the lateral part of tergite 1 reddish brown and its hind margin more dark reddish; broad, ring-like hind margins of tergites 2-8 ivory whitish (those of 6-8 narrower); hind margins of sternites 2-5 also broadly ivory whitish, that of sternite 6 much narrower and those of 7 and 8 very narrow and scarcely differently coloured from the dark colour of those sternites; apical part of lateral lobes of tergite 9, apical part of sternite 9, processes of latter, and aedeagal apparatus slightly paler reddish

brown; legs with the coxae dark, the base of middle ones yellowish brown, the membranous articulations between front and hind coxae and their respective sternal parts more yellowish, the legs themselves brownish, the hind femora in more than apical half laterally and below darkened blackish brown, and front and middle ones along outer or hinder aspect also darkened; all the tibiae appearing paler yellowish brown, the last 3 joints of front and middle tarsi, and last 2 of hind tarsi tending to be dark blackish brown, and apical curved part of claws black.

Integument of head in front, first and second antennal joints, proboscis, and rest of body mainly shining; propleural and prosternal parts, hinder half of mesopleuron, the pteropleuron, metapleural part however dulled by greyish white tomentum; a narrow central streak, a broader submedial streak on each side of mesonotum, a lateral notopleural streak, and a medial patch in front of scutellum also dulled by greyish tomentum; abdomen with tergite 1 markedly transversely convex, the rest with saddle-shaped dull patches discally above on more than basal halves of tergites 2–6, appearing dull black in certain lights, but covered with fine greyish white tomentum in other lights; integument of tergites with comparatively widely-spaced setiferous puncturation lodging the hairs, denser on tergites 1 and 2; sides of tergites 2–7 also showing indications of transverse striation in certain lights; bullae large, bean-shaped, shining black, separated by a space slightly narrower than transverse length of a bulla, their anterior margin marked off as a transverse row of coarse punctures, and anterior part of the disc of the bullae behind the anterior ridge with a row of pit-like punctures; legs subshining, with fine, slightly raised, setiferous puncturation lodging the hairs, the femora, especially hind ones and near the apex, with indications of transverse striae, and the tibiae too, especially hind ones, with indications of transverse striation.

Vestiture mainly snow white or silvery white, not very long, the longest and densest hairs in tufts on head in front, on vertex, upper occipital region, on humeral tubercles, sides of thorax above, in a patch in front of scutellum, on metanotum, especially sides, as sparse ones across hind margin of mesopleuron, and slightly denser ones on pteropleuron and metapleuron; hairs on sides of tergites 1 and 2 also long and dense, and also with a few sparse longish ones basally on sides of 3; hairs on disc of mesonotum arranged in the usual narrow central streak and 2 broader submedial ones, these hairs short and backwardly-decumbent and, excepting the longer white ones anteriorly, with a very faint sericeous yellowish tint; short decumbent hairs on abdomen above rather widely spaced, slightly denser discally on tergite 2 and to a lesser extent on 3, all with a very slight sericeous yellowish tint; hairs on venter more or less confined to middle part of sternites 2–6, also widely spaced and slightly gleaming sericeous yellowish, but slightly longer than on dorsum; hairs on sternites 7 and 8 like those dorsally; hairs on hypopygium equally widely spaced and also tinted sericeous yellowish; hairs on coxae dense and silvery white, those on front and middle femora above and behind dull white, longer and denser than

those on hind femora, and those on tibiae short, dense and gleaming very slightly sericeous yellowish; tomentum behind eyes greyish white, that on thorax and abdomen as stated above, but that on tergites 6,7 and sides of 8 not confined to saddle-shaped discal patches, but also faintly evident laterally; tomentum on hypopygial parts also faintly indicated.

Head much broader than thorax; interocular space on vertex subequal in width to the interocular space on head below, the inner margins of eyes converging above and below; some distinct postvertical spines detectable; clypeus comparatively short centrally, tending to be slightly longitudinally convex; proboscis comparatively long, about 2,8 mm long fully extended, much longer than vertical length of eyes; palps distinct, slender; antennae comparatively long, much longer than mesonotum, with joint 1 not much thickened, about $2\frac{1}{4}$ times length of 2, joint 3 the longest, slightly more than 3 times length of 1 and 2 combined, a little less than its apical $\frac{1}{3}$ slightly thickened; clubs elongate pyriform, shorter than joint 3, broadest at about apical third, their bases (a little less than basal $\frac{1}{4}$) markedly and sharply demarcated neck-like, with the conical apical sensory area also sharply demarcated by an almost encircling ridge, interrupted dorsally or laterodorsally where club passes apically into the vertical, slightly elongated, crater-like, apical prominence.

Wings greyish hyaline, with a very faint whitish tint in certain lights; veins yellowish brown; second submarginal cell with a short appendix; first posterior cell broadly opening on costal margin; hind border of wings much narrower than either first and third posterior cells; halteres pallid, the knobs darkened above.

Legs with the front and middle femora unarmed below; hind femora markedly thickened, subspindle-shaped, armed below with a double row of pallid spines on tubercles, about 5-7 in the inner row and 6 in the outer one which begins a little before the inner one; front and middle tibiae slightly curved, the spicules on front ones shorter than those on middle ones; hind tibiae also slightly curved beyond middle, the granules below distinct, those in outer row below with stoutish spine-like spicules in apical half, the rest of spicules on hind tibiae finer and shorter; basal joint of hind tarsi subequal to claw-joint.

Hypopygium (cf. Fig. 2, top right) with the lateral lobes of tergite 9 slightly produced apically; sternite 9 conical, slightly grooved obliquely on sides basally, its process on each side, in side view, not very long, slightly sinuous, the apex, in dorsal view, sharply pointed; aedeagal apparatus with the dorsal shoe-horn-shaped epimere rather narrow and much longer, quite 2 times, length of phallic tubes.

The ♀ specimen which I take to be the ♀ of this species is characterized as follows:

Body also mainly very dark blackish brown, the apical part of abdomen becoming more dark reddish brown; clypeus also reddish brown; antennae coloured as in ♂; proboscis however darker above; thorax with the humeral

tubercles also pale yellowish as in ♂, the area around them, especially anteriorly on inner side of tubercles, the sides of thorax, postalar calli, base of mesonotum, and scutellum however also yellowish; metanotum dark reddish brown antero-laterally, its central part black; pleurae as in ♂; abdomen with tergite 1 also markedly inflated and convex as in ♂, the sides of this tergite and its broad hind margin reddish brown; the very broad, ring-like, hind margins of tergites 2–6 ivory yellow, and a broad, discal spot occupying apical half of tergite 7 and extending on each side narrowly and obliquely towards hind margin also ivory yellowish; bullae shining black; venter also with broad ivory yellow hind margins across sternites 2–6, but 7 and 8 however without yellow hind margins; coxae more dark reddish brown than black; legs coloured as in ♂.

Integument of head and thorax as in ♂; abdomen however mainly smooth and shining, polished in appearance, with widely-spaced, fine, setiferous puncturation lodging the forwardly-directed hairs only on tergites 6–8 and with fine, scarcely detectable, setiferous puncturation on disc of tergite 2 and base of 3; venter mainly smooth and shining, with widely-spaced, fine puncturation only on sternites 7 and 8; tergites and sternites 7 and 8 also with transverse striation; integument of legs as in ♂.

Vestiture also mainly snow white; that on head, thorax, basal part of abdomen, and coxae similar to that of ♂, only slightly shorter; that on sides of tergites 1 and 2, metasternum and hind coxae also slightly shorter; fine and short, separated hairs on tergites 2 and 3 gleaming slightly sericeous yellowish in certain lights; middle parts of abdomen above mainly smooth; fine reversed hairs on tergite 6 and longer stiffer ones on 7 and 8, and bristly ones on genitalia, brown; sternite 2 with some separated whitish hairs; hairs on legs only a little shorter than in ♂; tomentum on head and thorax as in ♂, but without any tomentum on the smooth abdomen.

Head as in ♂, with the interocular space on vertex subequal in width to space below head; vertex not very deeply sunk in; postvertical spines more distinct; antennae as in ♂, the joints similar, with the same proportions; proboscis as long (about 2.8 mm) as in ♂, though slightly thicker and more darkened above; palps also slender, but with more dark hairs.

Wings differ from those of ♂ in being faintly infuscated brownish, and with indications of faint fuscous borders to basal cross vein and basal veins of first posterior cell and vein between it and second submarginal cell; latter with a longer appendix; first posterior cell however less widely opening on costal margin; hind border of wings in apical half less narrower than posterior cells than in ♂; halteres similarly shaped.

Legs very similar, but hind femora less thickened, armed below with a few more spines (7–8 in inner row and 7–9 in outer one); spicules on tibiae longer than in ♂; claws of tarsi shorter, more sickle-shaped, not so hook-shaped; pulvilli smaller.

Genital segments with 7 narrow yellowish brown spines on each acanthophorite of tergite 9; anal lobes prominent, pincushion-like on each side, with

projecting bristly hairs.

From a ♂ holotype and ♀ allotype in the South African Museum.

Length of body: about 16.5 mm

Length of wing: about 11–12 mm

Distribution

South West Africa: Kaokoveld: Orupembe (H. D. Brown, 1/5/70) (♂ holotype); 21 km south of Orupembe (H. D. Brown, 1/5/70) (♀ allotype).

This species is very near some dark forms of *mauricei* Beq. The ♂ may at once be distinguished by the much darker or black abdomen and venter, the longer antennae, distinctly very much longer third antennal joint, on the whole slightly longer proboscis, a first posterior cell in wings which opens more broadly on costal margin, more inflated or convex tergite 1, more widely-spaced setiferous puncturation (hairs) on abdomen, and distinctly much longer and relatively narrower epimere.

The ♀ may also be distinguished from that of *mauricei* by the antennal characters, the longer and denser hairs on thorax, pleurae, metanotum, and base of abdomen, the very broad yellow spot on apical half of tergite 7, the slightly less infuscated wings, and the less hairy legs.

Afroleptomydas (Crossoprosopus) cognatus n.sp.

Another dark-bodied ♂ from the same geographical region in South West Africa is so closely related specifically to the ♂ of *nigrescens* that it may almost be considered as a subspecies of the latter. This ♂ specimen however agrees and differs from the ♂ of *nigrescens* in the following respects:

Body longer, distinctly more robust, with more robust thorax and first and second abdominal segments, with tergite 1 however also markedly inflated and convex; abdomen distinctly stouter; body also mainly black; antennae with joints 1, 2 and 3 entirely black (not with 3 brown as in *nigrescens*); clypeus very dark blackish brown, not reddish brown; proboscis more darkened above; thorax with the humeral tubercles and postalar calli similarly coloured; abdomen including venter also mainly black, with the hind margin of tergite 1 also dark reddish brown, and ring-like hind margins of rest of tergites also broadly ivory white; bullae also black, but much longer in vertical length and longer than the interocular space; venter and hind margins of sternites similarly coloured; legs with the front and middle femora darker posterolaterally and below, the hind ones more extensively blackened on sides and apically above than in *nigrescens*, and hind tibiae also more darkened along outer part towards apex.

Integument also mainly shining, the mesonotum with coarse 'nadelrissig', setiferous puncturation; abdomen with similar dull, discal, saddle-shaped patches on tergites 2–6, but with distinctly coarser, more 'nadelrissig', comparatively less widely-spaced, setiferous puncturation on tergites; integument of legs subshining, slightly more transversely striate.

Vestiture distinctly longer and denser, but also mainly snow white, distinctly longer and denser on pleurae, sides of tergites 1 and 2, with more long hairs on sides basally of tergites 3 and 4; the hairs discally on mesonotum not arranged in such well-defined streaks, more or less only as a broad central streak; the shorter, more sericeous-gleaming, decumbent hairs on abdomen above distinctly much longer than in *nigrescens* and also less widely spaced, those discally on tergite 2 and basally on 3 distinctly very much denser; hairs on venter also longer and denser; those on legs very similar, but hind femora with longish white hairs on nearly basal half above; tomentum present on same parts as in *nigrescens*.

Head with the vertex distinctly more markedly sunk in, with no distinct postvertical spines detectable; antennae distinctly much stouter (the clubs missing in specimen), with joint 1 slightly more thickened, but also about $2\frac{1}{4}$ times length of 2, with joint 3 more thickened, stouter, very much shorter than in *nigrescens*; proboscis much stouter, slightly longer, about 3 mm.

Wings also greyish hyaline, comparatively broader, the hind border scarcely or not markedly narrower than first and third posterior cells; second submarginal cell with a long appendix; first posterior cell more narrowed apically, more narrowly opening on costal margin; discoidal cell in this specimen not stalked apically; halteres gradually broadened to knob on inner side as in *nigrescens*.

Legs comparatively longer than in *nigrescens*; front and middle femora also unarmed below, the hind ones slightly more thickened, armed below with the usual double row of spines, but with more numerous, shorter and stouter ones (8 along inner row and 9 in outer one), beginning much nearer base; basitarsus of hind legs longer than, not subequal to, claw-joint.

Hypopygium (cf. Fig. 2, bottom left) differs from that of *nigrescens* in having the processes of sternite 9, in side view, less sinuous, slightly longer, appearing more slender, in dorsal view less rapidly narrowed to apex, the latter more broadly rounded and with 2 distinct punctures; aedeagal apparatus with the epimere comparatively shorter and, in ventral view, more rapidly broadened to apex.

From the single ♂ holotype in the South African Museum.

Length of body: about 17.5 mm

Length of wing: about 13.5 mm

Distribution

South West Africa: Kaokoveld: 21 km south of Orupembe (H. D. Brown, 1/5/70).

From *damarensis* n.sp., described further on, which it also resembles, this species differs in being much larger, more robustly built, with longer and broader wings, longer first antennal joints, much shorter third antennal joints, much longer proboscis, stouter, more bluntly rounded sternite 9 of which the processes (cf. Fig. 2, bottom left and Fig. 1, bottom right), in side view, are

comparatively longer, more slender and, in dorsal view, do not diverge slightly outwards.

Afroleptomydas (Crossoprosopus) aridiculus n.sp.

Still another almost entirely black-bodied ♂ specimen from the Namib Desert in the collections before me constitutes another new species which closely resembles both *nigrescens* and *cognatus*, but more so the latter. Unfortunately the antennae of this specimen are missing. It agrees with and differs from the two species mentioned in the following respects:

Body tending to be more robustly built than in *nigrescens*, more like that of *cognatus*, the abdomen as stout as in the latter; body also mainly very dark blackish brown to black; clypeus very dark blackish brown as in *cognatus*; proboscis very dark reddish brown as in the latter species; humeral tubercles yellowish as in both *nigrescens* and *cognatus*, but the area immediately around them black, not yellowish brown or reddish brown; postalar calli slightly darker reddish brown; sclerites below wing-bases also dark reddish brown as in *cognatus*; sides of tergite 1 very dark, not yellowish brownish or reddish brown as in the other two species; abdomen with the hind margin of the distinctly less inflated tergite 1 dark, the hind margins of tergites 2-8 also broadly ring-like ivory yellowish, also becoming narrower posteriorly from tergite 5; bullae blackish red, black in the other two species, their vertical length sub-equal to interocular space on vertex, longer than in *nigrescens*, but shorter than in *cognatus*, fairly widely separated; venter yellowish brown in at least basal half, darker in the other species, the hind margins of sternites 2-6 broadly ivory whitish, but 7 very narrowly so, as in *cognatus*; apical parts of tergite 9, anal lobes, processes of sternite 9 and aedeagus yellowish brown; legs more yellowish than in the other two species, the upper and outer surfaces of the front and middle femora appearing darker, more brownish, the hind femora with more than apical half dark brown and the basal part contrastingly yellowish, more conspicuously delimited than in the other two species (in *cognatus* almost entire outer face is dark brown); all the tibiae paler yellowish, the hind ones not darkened or darkened towards apex; last tarsal joint also darkened.

Integument with the same parts shining as in the other two species; dorsum of mesonotum however appearing duller; that of pleurae very similar; abdomen with the same saddle-shaped, dull, discal, basal patches on tergites, but slightly more extensive, leaving less of the sides shining, these patches also covered with greyish to greyish yellow tomentum, visible in certain lights, the dorsum of abdomen also with setiferous puncturation, distinctly less widely separated than in *nigrescens*, more like that of *cognatus*, but slightly less coarse and with shorter hairs; venter also shining, finely setiferously punctured, though less dense than in *cognatus* and less coarsely transversely striated in apical half; integument of legs as dull as in *cognatus* and also with indications of transverse striation.

Vestiture very similar to that of the two other species, also mainly snow

white, though distinctly longer and denser than in *nigrescens*, but distinctly shorter than in *cognatus*, more of the clypeus dorsally covered with hairs which are slightly longer than in *cognatus*, the tufts on vertex tinted slightly more yellowish in certain lights; hairs on mesonotum not so distinctly and demarcately present as distinct streaks as in *nigrescens*, more like those of *cognatus*, the broad medial streak however broader than in the latter, leaving narrower, more or less hairless streaks on sides discally; these decumbent hairs also gleaming sericeous yellowish; hairs on pleurae present on the same sites, but longer and denser than in *nigrescens*, more like those of *cognatus*; long and dense white hairs on sides of tergites 1, 2 and 3 and 4 as in *cognatus*, but slightly shorter; decumbent ones on tergites longer and less widely separated than in *nigrescens*, but distinctly shorter than in *cognatus*, also gleaming slightly sericeous yellowish; hairs on venter distinctly shorter and slightly less dense than in *cognatus*; hairs on coxae as in the latter, but comparatively shorter; hairs on legs with those on front and middle femora also long and dense, but slightly shorter than in *cognatus*, those on hind femora however distinctly less dense and shorter than in either of the other two species.

Head with the vertex less deeply sunk in than in *cognatus*, but slightly more so than in *nigrescens*; interocular space on vertex also subequal to space on head below; postvertical spines, as in *cognatus*, not detectable; antennae with joint 3 and club missing in specimen, but joint 1 slightly thickened, quite $2\frac{1}{4}$ times length of 2; proboscis about 2.7 mm long, distinctly shorter than that of *cognatus*, longer than vertical length of eyes, its labella shorter and more rounded apically than in the other two species; palps also slender.

Wings very faintly yellowish hyaline; veins yellowish, not brownish as in *cognatus*; second submarginal cell with an appendix; first posterior cell narrowed apically, even more so than in *cognatus*, narrowly opening on costal margin; discoidal cell shortly stalked as in *nigrescens*; halteres pale yellowish white, the knobs darkened above.

Legs slightly longer than in *nigrescens*, more like those of *cognatus*; front femora armed below along inner aspect with a row of distinct, short, spine-like bristly hairs, not detectable in the other two species; hind femora thickened, subspindle-shaped, armed below with an inner row of 10–11 and an outer row of about 9 whitish spines, beginning near base, thus with 2 or 3 more spines in outer row than in *cognatus*; spicules on tibiae longer, as long as or longer than width of tibiae, shorter than this width in the other two species; basitarsus of hind legs longer than claw-joint.

Hypopygium (cf. Fig. 2, bottom middle) with the lateral lobes of tergite 9 slightly angularly produced; sternite 9 conical, bluntly rounded apically, obliquely grooved basally on each side and then continued longitudinally, its dorsal processes projecting much beyond apex of sternite, in side view long and slender, only slightly curving upwards near apex, in dorsal view grooved above along inner aspect, slightly bent outwards near apex, the latter relatively bluntly pointed; aedeagal apparatus with the shoe-horn-shaped epimere

relatively shorter than in the other two species, about 1.6 times length of phallic tubes (in *nigrescens* and *cognatus* it is quite twice length of the tubes).

From the single ♂ holotype in the South African Museum.

Length of body: about 17.5 mm

Length of wing: about 12.5 mm

Distribution

South West Africa: Arechadamab, east of Swakopmund in the Namib Desert (H. D. Brown, 11/5/1959).

Afroleptomydas (Crossoprosopus) damarensis n.sp.

Another black-bodied ♂ specimen from South West Africa in the collections of the Stuttgart Museum and submitted by Professor Lindner is apparently a new species resembling *mauricei* Beq. from the Kalahari in Botswana, and also resembles *nigrescens* n.sp. It has two identification labels 'Gen. nov. pr. ? Mydaselpis Bezzi' and '? rufithorax Wied. det. H. Oldroyd, 1957' pinned under the locality label. It is however not related to either the genus *Mydaselpis* or to the Cape species *Afroleptomydas rufithorax*.

When compared with ♂♂ of the variable species *mauricei*, especially the darker forms, it agrees and differs from the latter in the following respects:

Body almost entirely black; proboscis entirely black, not infused with reddish brown or reddish below; clypeus much darker; antennal joints 1 and 2 dark blackish brown, not so yellowish as in *mauricei*, the broad middle part of clubs however also orange yellowish; humeral tubercles, which are comparatively smaller, also yellowish; rest of thorax, excepting obscure reddish brown postalar calli and yellowish brown sclerites below wing-bases, entirely black; abdomen mainly black, without any yellowish or brownish as in *mauricei*, the extreme sides of tergite 1 also black, but hind margin of tergite 1 however also reddish brown; bullae black anteriorly and reddish posteriorly (entirely black in *mauricei*), smooth, without any punctures; ivory yellowish hind margins of tergites 2-7 broader, more broadened on extreme sides, and with those of 6 and 7 broader than in *mauricei*; hind margins of sternites very broadly and conspicuously ivory yellowish, even those of 6 and 7 comparatively broad; lobes of tergite 9, sternite 9, and processes of latter yellowish brown; legs mainly very pale yellowish brown, the front and middle femora not darkened above or below, the hind ones conspicuously black above in apical half, the black patch-like and well marked off, not merely infused to a variable extent as in *mauricei* and other species, with the hind tibiae darkened apically and the claw-joints of all the tarsi darkened.

Integument very similar to that of *mauricei* and related species of the subgenus *Crossoprosopus*.

Vestiture very similar to that of *mauricei* and equally long, also mainly white, the longish hairs on head, mesonotum, pleurae, and abdomen basally however appearing to be slightly more dirty whitish than snow whitish (the

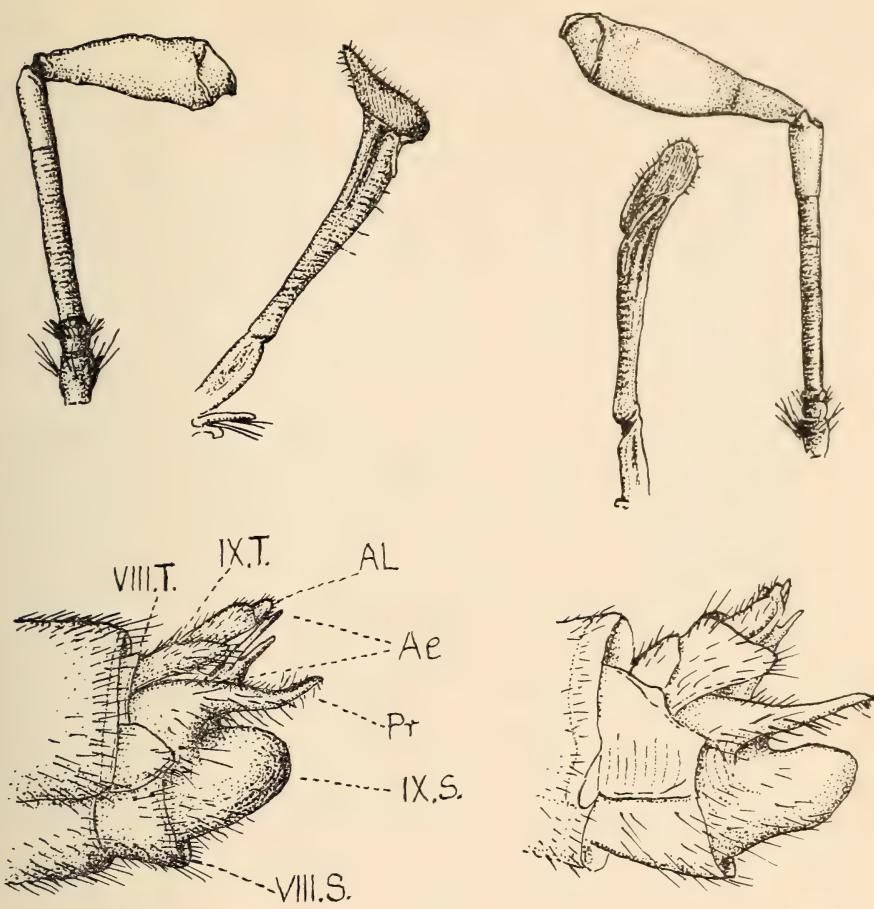


Fig. 1.

Left: Dorsal view of right antenna, proboscis, and below, left view of hypopygium of ♂ *Afroleptomydas lindneri* n.sp.

Right: Proboscis, side view of left antenna, and below left view of hypopygium of ♂ *Afroleptomydas (Crossoprosopus) damarensis* n.sp.

(Ae = aedeagus; AL = anal lobes; IX.S. = sternite 9; IX.T. = tergite 9; Pr. = left process of sternite 9; VIII.S. = sternite 8; VIII.T. = tergite 8.)

specimen however appears to be slightly greasy); hairs on mesonotum similarly disposed in streaks; those on sides of tergite 4 also long as on sides of preceding tergites, not shorter than on sides of 3 as in *mauricei*; longish hairs on venter also present on sternite 4; fine, decumbent hairs in fine setiferous punctures on rest of abdomen above appearing slightly more sparsely disposed than in *mauricei*; greyish white tomentum on head, thorax above, metanotum, pleurae and on abdomen above similar to that of *mauricei* and most other species of the subgenus; that on abdomen above in this somewhat greasy specimen however appears dark in part; hairs on legs as in *mauricei*, long, dense and white on coxae,

slightly long and dense on upper and outer faces of front and middle femora, and comparatively sparse and short on hind ones.

Head with the antennae (cf. Fig. 1, top right) comparatively longer than in *mauricei*, distinctly much longer than mesonotum; joint 1 proportionally shorter than in latter, less slender and only about twice length of 2; joint 3 proportionally longer, with a slightly longer apical thickened part, the club also elongate amphoriform, broadest beyond middle, its apical sensory area distinctly more conical all round, not sunk in on inner lower part, the apical crater-like tubercle distinctly more rounded, not so transverse as in *mauricei*; proboscis (cf. Fig. 1, top right) proportionally much shorter, only about 1,8 mm long and subequal in length to third antennal joint, its labella proportionally short, apically bluntly rounded (not sharply pointed), and with slightly fewer striae.

Wings, in proportion to body-length, relatively shorter than in *mauricei*, more glassy hyaline, without any distinct indication of a faint yellowish tint; veins pale yellowish brown; first posterior cell slightly narrowed apically, subtending angularly on costal margin; halteres like those of *mauricei*.

Legs proportionally distinctly shorter than in *mauricei*; hind femora similarly thickened, but more spindleshaped, the thinner basal part being proportionally shorter, armed below with the usual double row of pallid spines on tubercles which are however closer together, due to the shorter femora, but also with about 9 spines in both inner and outer rows; hind tibiae as granular below; spicules on tibiae and tarsi as in *mauricei*.

Hypopygium (cf. Fig. 1, bottom right) similar to that of *mauricei*, but sternite 9 more conically produced, its apex not so bluntly rounded and itself apparently longer, its processes, in side view, distinctly less sinuously S-shaped, straighter, its apex scarcely or not bent downwards, in ventral view, the apex is more curved outwards; epimere of aedeagal complex comparatively and proportionally shorter relative to phallic tubes.

From the single ♂ holotype in the Stuttgart Museum.

Length of body: about 15,5 mm

Length of wing: about 9,5 mm

Distribution

South West Africa: Khomashochland (17/5/1953). No collector's name appears on the locality label, but the handwriting is that of Herr F. Gaerdes of Okahandja.

From the ♂ of *nigrescens*, which is also mainly dark-bodied and with dark abdomen, it may be distinguished by the entirely dark and much shorter proboscis, shorter and rounded labella, absence of yellowish brown on extreme sides of tergite 1, half reddish bullae, comparatively shorter wings, hind femora which have a contrasting, patch-like, black infusion above, denser hairs on abdomen above, and relatively shorter epimere in the aedeagal apparatus.

Afroleptomydas (Crossoprosopus) aquilus n.sp.

A somewhat damaged, markedly bare ♀ specimen from Damaraland in the collections before me cannot be allocated to any of the known ♂♂ from South West Africa. Superficially it resembles some ♀ forms of *mauricei*, but is entirely distinct. It is characterized as follows:

Body mainly very dark blackish brown to black; clypeus very dark, dark blackish brown; proboscis dark reddish brown, more black above and on labellar part; antennal joints 1 and 2 dark reddish brown, joint 3, almost basal half of clubs and apical tubercle part of latter very dark blackish brown or almost black, the greater middle part of clubs however orange yellowish; humeral tubercles yellowish; extreme sides of mesonotum very obscurely reddish brownish in certain lights, the postalar calli more yellowish, and extreme base of mesonotum reddish brown; scutellum black; metanotum black, its extreme base behind scutellum and two submedial streaks obscurely yellowish brown; pleurae very dark blackish brown to black; sclerites below wing-bases and sutural parts of pteropleuron yellowish brown, and the sclerite below halteres yellowish; extreme sides of tergite 1 also yellowish; abdomen with transverse depressed hind margin of tergite 1 reddish brown, the broad hind margins of tergites 2–7 yellowish, those of 6 and 7 broad discally, that of 7 even extending basalwards to more than half of the tergite, and tergite 8 mainly reddish brown discally, becoming paler apically; bullae comparatively small, black, but orange yellowish across hind margin, not punctured, very widely separated; venter dark or black, its base yellowish and hind margins of sternites 2–7 broadly yellowish, the last one the narrowest; legs mainly pale yellowish, the front and middle coxae, basal halves externally of hind ones dark, very dark blackish brown, and an inner subapical infusion and also an outer more obscure or fainter apical one on hind femora dark brownish.

Integument of head in front, greater part of sides of propleuron, the mesopleuron, sternopleuron, part of hypopleuron behind and below halteres, and to a large extent abdomen above and below shining; rest of pleurae slightly duller, covered with fine greyish bloom or tomentum; mesonotum duller, more subshining, more leathery, covered with fine separated, setiferous punctures, more or less in streaks; scutellum and metanotum dull, leathery; tergites 1 and 2 discally subshining, covered with fine, separated, setiferous punctures, denser on sides; rest of tergites with comparatively sparse, fine, setiferous punctures discally, their sides transversely striate, becoming coarser on sides of 5–7; tergites 7 and 8, especially latter, more coarsely striate or grooved, even discally; integument of venter mainly smooth, shining, more transversely striate on last three sternites; legs subshining, the femora transversely striate, the hind tibiae more evidently so below.

Vestiture very poorly and sparsely developed, markedly short; that on head in front relatively short and sparse, snow white, comparatively shorter than in other mainly bare species; that on sides of clypeus short, not extending across genal furrows; those on head below sparse; hairs on occiput also sparse

and white, with whitish postvertical spines on each side; sides of occiput with comparatively sparse greyish white tomentum; hairs on thorax above very short, decumbent, slightly sericeous yellowish in certain lights, more or less arranged in streaks; those on sides of mesonotum also relatively short, not as long as in some other species; metanotum with very short, sparse, yellowish hairs discally; posterior margin of mesopleuron with scarcely detectable, short, yellowish gleaming hairs; propleural knob however with sparse, longish, white hairs; rest of pleural sclerites without any detectable, short hairs, only with fine, rather sparse, greyish bloom or tomentum; discal part of tergite 1 with markedly short, sparse, yellowish or golden gleaming hairs, even shorter, sparser, scarcely detectable on sides of the tergite; tergite 2 with similar, very short, yellowish or golden gleaming hairs, slightly denser and shorter on sides; tergite 3 with even sparser, short, yellowish gleaming hairs; tergites 4 and 5 with very short, very sparse, widely-separated, golden gleaming hairs mainly discally; tergite 6 with sparse, forwardly-directed, very short, brownish hairs; tergites 7 and 8 with longer, widely-spaced, forwardly-directed, brownish hairs, slightly longer and denser on 8; venter mainly smooth and hairless, only last sternite with some forwardly-directed, sparse hairs on sides; hairs on legs markedly short and comparatively widely spaced, gleaming sericeous yellowish or golden, even the denser ones on front and middle femora also very short.

Head with the vertex somewhat sunk in; the interocular space on vertex slightly broader than on head below; antennae about subequal in length to mesonotum, with joint 1 only slightly thickened, about $2\frac{1}{3}$ times length of the rather short transverse joint 2, joint 3 slightly longer than club, a little more than its apical $\frac{1}{3}$ thickened, the clubs elongate pyriform, broadest beyond middle across a little more than apical $\frac{1}{3}$, their bases constricted neck-like, the apical sensory area more rapidly narrowed below, the rim below of crater-like terminal prominence rather prominently projecting; proboscis about 2.4 mm long, longer than vertical length of eyes, its labella broad, obtusely pointed apically; palps small, but distinct.

Wings (left wing of this specimen unfortunately missing) relatively long, faintly tinted yellowish brown throughout, the veins yellowish brown; first posterior cell broadly opening on costal margin, scarcely or not narrowed apically; second submarginal cell with an appendix; discoidal cell shortly stalked apically; halteres racket-shaped, their broadened apical part darkened above.

Legs moderately long; hind femora slightly thickened, subspindle-shaped, broadest slightly beyond middle, armed below with the usual double row of relatively short, yellowish white spines on tubercles, about 7 in both rows; front and middle femora unarmed below, front and middle tibiae slightly curved, the spicules on former not so well developed as on middle ones; spicules on tubercles in outer lower row in apical half of hind tibiae stout and spine-like; basal joint of hind tarsi slightly longer than claw-joint; hind claws more strongly developed, sickle-shaped, those of front tarsi least developed, more

hook-like; pulvilli well developed, but not reaching apices of claws.

Genital segments with tergite 8 slightly pointed apically; acanthophorites each with 6 detectable brownish, dorsally-grooved and apically bluntly-pointed spines, the last (or apical) one being spine-like; anal lobes with some stoutish spine-like bristles basolaterally.

From the single ♂ holotype in the South African Museum.

Length of body: about 15.3 mm

Length of wing: about 12 mm

Distribution

South West Africa: Damaraland: Karibib (H. D. Brown, 20/5/1959).

The ♀ of this species may be easily recognized by its marked bareness and feebly-developed vestiture on body. Superficially this ♀ resembles the ♀♂ of some similarly-coloured forms of *mauricei* Beq., but may at once be distinguished by the absence of longish hairs on ptero- and metapleurae, sides basally of tergite 1, and basolaterally on hind coxae, distinctly longer antennae, more broadly opening first posterior cell, and fewer spines on acanthophorites.

From the ♀ of *matetsiensis* Beq., which is also very bare, it may be distinguished by the mainly black body, absence of even, sparse longish hairs on ptero- and metapleurae, sides of metanotum and first tergite, slightly longer antennae, broadly yellow discal hinder part of tergite 7, dark infusion laterally on apical part of hind femora, etc.

The possibility that this ♀ may be that of the ♂ *damarensis* n.sp., which is also very dark bodied, with mainly dark clypeus, antennae, and proboscis, and also with very pale legs, is however ruled out by the distinctly very much longer antennae, much shorter proboscis, apically much narrowed first posterior cell, and more numerous spines on hind femora below of the ♂ *damarensis*.

Afroleptomydas (Crossoprosopus) femoralis n.sp.

A pale-coloured ♂ specimen from South West Africa, with comparatively thickened hind femora and belonging to the pale-coloured *matetsiensis*-section, is a new species which is characterized as follows:

Body rather stout and robust, with broad and robust thorax and base of abdomen, with the abdomen thickened and cylindrical; the body and legs mainly pale coloured, pale yellowish red to yellowish brown; frons and vertex black; proboscis reddish, its labella mainly black; a middle streak on anterior half of mesonotum and a broadish sublateral streak on sides of mesonotum darkened or black, ending posteriorly on each side in a smooth dark spot; mesopleural and sternopleural parts obscurely darkened, more brownish or castaneous; metanotum also darkened, more brownish in hinder half; hind margins of tergites, including tergite 8 broadly and conspicuously ring-like, yellowish white, becoming narrower on posterior tergites; hind margins of sternites 1-7 also broadly yellowish white; sides of transverse basal depression of tergite 2 slightly darkened; tergites 2-5 basally obscurely darkened, and

extreme sides of 5-7 and more or less basal half of sternite 8 also darkened, more blackish brown; anal lobes tending to be paler, more yellowish; bullae transversely elongate, widely separated, their posterior halves orange yellowish and anterior halves black and shining, the extreme hind margins also darkened, their anterior margins with a row of granules; legs mainly pale yellowish brown, the anterior and middle trochanters darkened behind, the outer faces of femora, especially hind ones, showing through very slightly dark in certain lights, with the spines on hind femora below pallid on reddish yellow tubercles, the granules below hind tibiae shining dark reddish brown to almost black, and apical halves of claws black.

Integument of central part of frons, clypeus and head below shining; that of mesonotum dull, leathery, with setiferous puncturation lodging the short decumbent hairs; scutellum smooth, shining; metanotum mainly dull; pleurae mainly dull, but propleural and sutural parts, as well as sclerites below wing-bases, more or less shining; abdomen mainly dull, but lateral basal parts of tergites and ring-like hind margins subshining, the tergites mainly setiferously punctured, lodging the hairs; sides of exposed parts of tergite 8 and processes of sternite 9 shining; venter subshining, the pale hind margins of sternites more shining; legs with the trochanters shining, the femora subshining, more shining below, the femora and tibiae with fine setiferous puncturation, lodging the hairs.

Vestiture rather dense, dense, long and creamy whitish on head, sparser and more white on head below; that on thorax above dense, creamy white, longer on sides and posteriorly in front of scutellum; that on disc of mesonotum shorter, directed backwards, gleaming sericeous yellowish, arranged in a narrow central denser streak and two broader submedial denser streaks, and a broadish sublateral, less dense, barer streak, ending posteriorly in an entirely bare spot on each side; pleurae with faint tomentum on dull parts, the long hairs across hind part of mesopleuron, on pteropleuron, and metapleural parts also creamy white; longish dense hairs on metanotum, tergite 1 (and its sides), tergite 2, on sides especially, and to a feebler extent basally on sides of 3 also creamy white; short, backwardly-directed hairs in setiferous punctures on rest of abdomen above not very dense, gleaming sericeous yellowish to pale golden, slightly longer and sparser on sides of tergites; hairs on venter slightly longer than on dorsum, sparser, also gleaming sericeous yellowish to pale golden; hairs on hypopygium rather sparse, pale golden; those on legs gleaming pale sericeous yellowish, slightly longer and denser on femora above, comparatively dense on front and middle femora above; tomentum on head dense, greyish white, present on sides of frons, vertex and behind eyes; greyish tomentum also present on mesonotum along the streaks of hairs; metanotum also with faint greyish tomentum.

Head broader than thorax, with the vertex sunk in, interocular space on vertex subequal to length of central part of frons to antennae and also subequal to narrowest part of width of interocular space on head below; some slender whitish postvertical spines present; antennae with only joints 1 and 2 present

in specimen, the former quite $2\frac{1}{2}$ times length of the comparatively short joint 2 and not much thickened; clypeus with an indication of a central groove; proboscis about 1.96 mm long, much shorter than vertical length of eyes, its labella a little less than twice length of rest of proboscis; palps small.

Wings glassy hyaline, with a scarcely perceptible milky whitish tint in certain lights; costal vein, basal part of second vein and parts of veins at base of wings yellowish, the rest darker, more brownish; second submarginal cell with an appendix; first posterior cell slightly narrowed apically, opening (or sessile) on costal margin; discoidal cell shortly stalked apically; halteres whitish, their knobs slightly darkened medially above.

Legs stoutish; hind femora markedly thickened, more so than in most other species, armed below with a double row of rather short, stout, whitish spines on tubercles (11–12 in outer row and 11 in inner row, beginning near base) and in right femur also with a small sublateral, subapical spine on each side; front and middle femora unarmed; front and middle tibiae slightly curved, the front ones with an outer lower row of large spicules, those on dorsum small, the middle tibiae with more or less two rows of longer spicules below and two irregular rows of shorter ones above; hind tibiae with irregular rows of setiferous granules below, the outermost ones in apical part with longer and stouter spicules; basal joint of hind tarsi dorsally subequal in length to claw-joint.

Hypopygium with the lateral lobes of tergite 9 rather sharply angular; sternite 9 relatively rather small, conical, bluntly rounded apically and there medially sulcate, its processes projecting much beyond apex of sternite, their slender part, in side view, almost straight, more narrowed and rounded apically in dorsal view; aedeagal apparatus with the phallic tubes much shorter than the shoe-horn-shaped dorsal epimere.

From the single ♂ holotype in the South African Museum.

Length of body: about 19 mm

Length of wing: about 12 mm

Distribution

South West Africa: Kaokoveld: Otjivakandu (sometimes spelled Otjivakondo) (H. D. Brown, 27/4/1970).

From the ♂ of *matetsiensis* Beq., which it resembles superficially, it may however be distinguished by the distinctly stouter body, shorter proboscis, denser hairs on head in front, denser and longer hairs on the usual hairy parts of body, broader ring-like hind margins of tergites, more orange-coloured discal part of bullae, more thickened hind femora, more numerous granules on hind tibiae below, and straighter, less sinuous processes of sternite 9.

Afroleptomydas (Crossoprosopus) browni n.sp.

Some ♂♂ and ♀♀ from the Okovango River region in the collections constitute a new species belonging to the mainly pale-coloured *matetsiensis*-section. With great pleasure this new species is named after the collector and

donor, Dr H. D. Brown, of the Department of Agricultural Technical Services. The ♂♂ are characterized as follows:

Body with the head mainly black; clypeus, buccal cavity, and to a certain extent lower parts of genae and head below, yellowish brown to dark reddish brown; proboscis yellowish brown below, usually darkened above, the labella mainly dark to black; antennal joints 1 and 2 yellowish to yellowish brown and basal part or half of 3 also yellowish brown to reddish brown to a variable extent, rest of 3 and basal part of clubs dark or black; greater part of clubs conspicuously orange yellow, the sensory area sometimes also darkened; thorax above dark or black, the humeral tubercles, area around them, notopleural sides of mesonotum, postalar calli, narrow base of mesonotum, and scutellum yellowish brown to reddish brown, the humeral tubercles themselves more conspicuously pale yellowish, and sometimes with an indication of a faint narrow, sublateral, reddish or yellowish streak discally on each side of mesonotum; connection between postalar calli and scutellum with a conspicuous black spot, continuous with the black hollow on each side of scutellum; metanotum reddish brown to dark reddish, usually darker centrally and to a variable extent in apical half, sometimes paler on extreme sides; pleurae with the anterior and lower parts darkened or black to a variable extent, the upper anterior part of mesopleuron, area below wing-bases, pteropleuron (or apical half of it), and metapleural parts around and below halteres, and hypopleural part being yellowish brown, with a black spot or streak anteroventrally to posterior spiracle, extending down, sometimes broadly, to metasternum, the sternal parts also mainly dark or black to a variable extent; abdomen cylindrical, mainly reddish brown, the discal basal half or more of tergite 1 and to a variable extent the extreme lateral margins of the tergites black or darkened; tergites 3-7 sometimes discally appearing slightly darkened in certain lights; hind margins of tergites 1-8 broadly yellowish white, the bases of these rings tinted orange to a variable extent; venter yellowish to yellowish brown, the hind margins of sternites also broadly yellowish, more evident on sides, the medial part shining through more brownish; bullae black, shining, not pitted; legs mainly reddish brown, the tibiae and tarsi sometimes appearing more yellowish, the base of hind tibiae sometimes more yellowish, the apices of claws black.

Integument of central part of frons, clypeus, and head below as usual smooth and shining; that of proboscis and labella, antennal joints 1 and 2, and basal part of 3 also shining; mesonotum dull, leathery, with some setiferous punctures lodging the vestiture where present; postalar calli and scutellum more shiny; metanotum transversely slightly rugulose on sides, mainly dulled by tomentum; pleurae mainly dulled by fine bloom or tomentum; abdomen dulled by a slight greyish bloom which in these mounted specimens gives it a slight oily appearance, the underlying integument very finely microareolate and with fine, separated, setiferous puncturation lodging the hairs, the transverse basal depression of tergite 2 and much narrower one across 3 shining, and the extreme

sides of tergites (not covered with bloom) also shining; ring-like hind margins of the tergites more or less subshining; tergites 3-7, in certain lights, showing shallow, transverse striae on sides; venter smooth, shining, with indications of transverse striation on sides of sternites and on posterior sternites, the integument also with fine, separated, setiferous puncturation where hairs occur; legs subshining, the femora more shining below, with indications of transverse striation on both femora and tibiae, the surface also covered with fine setiferous puncturation lodging hairs.

Vestiture moderately long, mainly white; hairs in tufts on head in front very dense, snow white, leaving bases of antennae, space below antennae, and dorsum of clypeus bare; rest of long white hairs on vertex, occiput, and head below not so dense; whitish or pale yellowish white postvertical spines present, shortish and bristle-like; sides of frons and face narrowly, sides of vertex, and most of occiput to lower part of eyes densely covered with greyish white tomentum; hairs on mesonotum more or less arranged in 5 streaks, the central one narrowest, the broad one on each side composed of dense, decumbent, longish, snow white hairs, the submedial streaks begin with a patch of dense, longish, white hairs which become shorter discally and also less dense, sometimes with a scarcely perceptible sericeous yellowish tint, the narrow central streak of short, decumbent, whitish or pale sericeous yellowish hairs end in a patch of denser, longer, snow white ones in front of scutellum, the broad lateral and submedial streaks also with greyish tomentum; hairs on metanotum fairly dense, long, snow white, directed forwards and absent from a broad central streak, the surface also with greyish tomentum; pleurae mainly with fine, slightly greyish yellow bloom or tomentum, the hind margin of mesopleuron with or without a few longish white hairs, the pteropleuron and area in front of halteres with sparse, longish, white hairs, but hypopleuron and area below halteres conspicuously bare; prosternal and metasternal parts however with longish white hairs like the dense white ones transversely across in front of hind coxae; abdomen with fairly long, dense, snow white hairs basally on tergites 1 and 2, especially on sides, with some long ones also on sides of tergite 3 basally and some shorter ones on sides of 4; rest of abdomen above with short, decumbent, somewhat separated, slightly sericeous yellowish gleaming hairs in fine, setiferous punctures, slightly denser discally on tergite 2 and slightly longer on sides of tergites; decumbent hairs on venter very slightly longer than above, also gleaming slightly sericeous yellowish, absent from extreme sides of sternites; hairs on hypopygium as separated as on tergites, more or less equally spaced, very slightly longer, but also gleaming pale sericeous yellowish; hairs on legs comparatively short, long and snow white only on outer side of hind coxae, gleaming slightly sericeous yellowish in certain lights on rest of legs, those ventro-laterally on outside of femora slightly longer than dorsally.

Head broader than thorax; vertex sunk in, the interocular space on vertex subequal in width to, or only very slightly broader than, space below head, the margins of eyes converging above and below; antennae subequal in length to

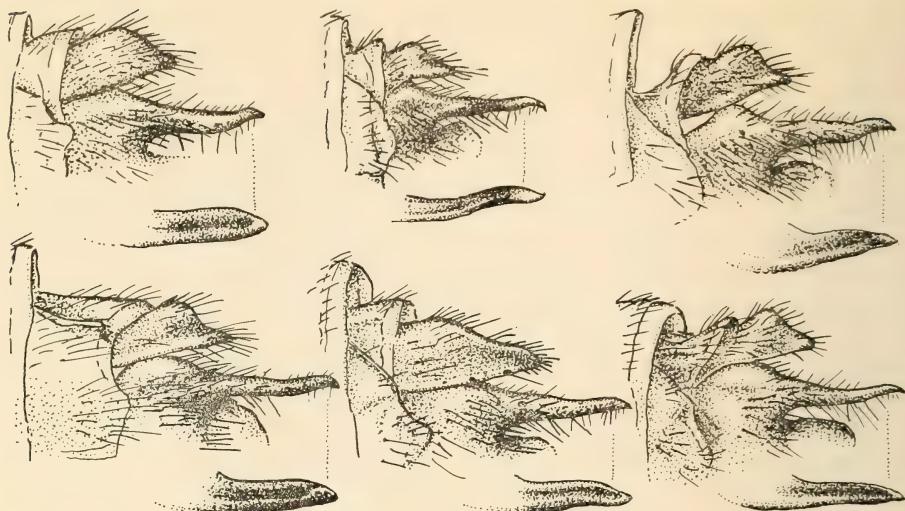


Fig. 2.

Side view of left lateral lobe of tergite 9 and side and dorsal views of left process of sternite 9 of ♂♂ (all to same scale) of:

- Afroleptomydas (Crossoprosopus) angolensis* n.sp. (top left).
- Afroleptomydas (Crossoprosopus) ovamboensis* n.sp. (top middle).
- Afroleptomydas (Crossoprosopus) nigrescens* n.sp. (top right).
- Afroleptomydas (Crossoprosopus) cognatus* n.sp. (bottom left).
- Afroleptomydas (Crossoprosopus) aridiculus* n.sp. (bottom middle).
- Afroleptomydas (Crossoprosopus) browni* n.sp. (bottom right).

mesonotum, with joint 1 only slightly thickened, about $2-2\frac{1}{3}$ times length of 2, joint 3 about, or usually a little more than, 3 times combined length of 1 and 2, usually a little shorter than club, the latter elongate pyriform, broadest beyond middle nearer apex, sometimes slightly constricted at about the middle, with a distinct, well-marked-off, basal, neck-like constriction, its apical sensory area demarcated by a ridge below, rapidly conically narrowed below to the crater-like tubercle; proboscis comparatively short and stout, slightly upcurved, shorter than vertical length of eyes, about 1.8–2 mm, its labella about a third, or a little more, of its length; palps small, but distinct, with some brownish hairs.

Wings clear hyaline, with a very faint yellowish tint in certain lights; costal and subcostal veins yellowish, the rest of veins yellowish brown, those in hinder part more brownish; base of second submarginal cell more often acute, sometimes however truncated, with an appendix; first posterior cell narrowed apically, more often narrowly opening on costal margin, occasionally just subtending on it or even broadly opening on it; discoidal cell usually shortly stalked apically; halteres racket-shaped, pallid, the broadened apical part usually darkened above to a variable extent.

Legs moderately long, the front and hind femora subspindle-shaped, but hind ones much thickened; front and middle ones unarmed below, but thickened

hind ones armed below with the usual double row of whitish to yellowish white spines on dark tubercles (about 9–11 in outer row, beginning near base and 7–11 in inner row); tibiae slightly curved, the spicules along inner and lower aspect of front ones not developed and those along outer lower aspect less developed and shorter than on middle tibiae as are also the apical spurs; spicules on hind tibiae on small tubercles, those from middle towards apex in both the inner and outer rows becoming longer; basal joint of hind tarsi subequal to, or only very slightly longer than, claw-joint; claws well developed, the hind ones longer, more sickle-shaped; pulvilli well developed.

Hypopygium (cf. Fig. 2, bottom right) with the lateral lobes of tergite 9 slightly produced and angularly pointed; sternite 9 navicular, longitudinally striated, apically with a vertical sulcus, in side view conical, bluntly or roundly pointed apically, its dorsal process or prong on each side projecting much beyond the sternite, in side view slender, slightly upcurved near apex, its sharp apex slightly bent down, in dorsal view slightly hollowed, narrowed apically and fairly sharply pointed, the apices slightly diverging; aedeagal apparatus with the shoe-horn-shaped epimere slightly broadened apically, projecting beyond and longer than the divergent phallic tubes.

The ♀ specimens, caught at the same time as the ♂♂ and at the same localities, which I take to be the ♀♀ of this species, are characterized as follows:

Body mainly or almost entirely reddish brown to dark brown; frons black and shining; clypeus and head below dark reddish as in ♂, the former also brilliantly shining; proboscis as in ♂ yellowish brown below, the lower half and apex, or entire labella, darkened; antennae similarly coloured, joint 3 tending to become darkened, the greater part of clubs sometimes even more conspicuously orange yellow; thorax above more dark reddish brown to blackish brown, a middle streak and a broader sublateral one on each side tending to be slightly darker than the rest; humeral tubercles yellowish as in ♂; scutellum, metanotum, and pleurae similarly coloured, but latter sometimes more uniformly reddish brown; abdomen stouter, sometimes broad, dorsoventrally depressed, mainly reddish brown to dark reddish brown, the anterior transverse depression and anterior discal half of tergite 1 dark or blackish brown as in ♂; hind margins of tergites 1–5 discally very broadly yellowish, narrower on sides, that of 5–7 extending basalwards discally, and tergites 6 and 7 discally extensively infused yellowish, with 7 almost entirely so discally, their extreme hind margins discally not yellowish but narrowly darkened; basal part and sides of tergite 7 and to a variable extent extreme sides of 2–6 sometimes much darkened; bullae black and shining as in ♂; tergite 8 mainly dark reddish brown, more yellowish apically; venter mainly yellowish brown to dark reddish brown, the hind margins of sternites shining through brownish as in ♂, only extreme sides and sometimes extreme hind margins of 1–6 narrowly yellowish to a variable extent; legs coloured as in ♂, though sometimes darker, the tibiae and tarsi sometimes appearing more obviously yellowish, sometimes basal part of hind tibiae more distinctly yellowish.

Integument of head in front, antennal joints 1 and 2, proboscis, and abdomen above and below mainly smooth and shining; thorax above, metanotum and pleurae dull as in ♂, covered with faint bloom or tomentum, the metanotum transversely grooved on sides; mesonotum dull, leathery, with streaks of fine setiferous puncturation where fine hairs are present; tergites 7 and 8, especially the latter, transversely striated or grooved, and sides of 3–6 sometimes also showing transverse striation to a variable extent; legs subshining as in ♂, the fine transverse striation on femora more evident.

Vestiture, unlike that of ♂, poorly developed; short hairs on vertex, anteriorly across frons, across sides of clypeus, and on head below shorter than in ♂ and with a distinct sericeous yellowish tint, those on sides of clypeus sometimes even more yellowish or golden; those on occiput also shorter than in ♂; postvertical spines more evident and sometimes more yellowish brown; greyish yellowish tomentum narrowly present along eye-margins and dense, greyish white tomentum also present on occiput as in ♂; hairs on mesonotum very fine, short, gleaming sericeous yellowish to slightly golden and arranged in streaks as in ♂, those on sides of mesonotum very fine, short, not dense and whitish as in ♂; hairs on pleurae almost absent and very short; those on metanotum very short, fine, scarcely detectable; tergites 1 and 2 discally with fine, greyish bloom or tomentum; tergite 1 discally also with fine, short hairs; sides of tergite 1 with fine, short, sericeous yellowish hairs; tergites 3–6 mainly smooth; tergites 7 and 8, especially latter, with forwardly-directed, dark brown or blackish brown hairs; hairs on genital segments also blackish brown; venter smooth, bare and shining, with fine, short, reversed, widely-spaced, yellowish brown hairs present only on last two sternites; hairs on legs as in ♂, but only shorter, those on coxae also much shorter and sparser and more sericeous yellowish.

Head similar to that of ♂; proboscis similar, about 1.5–1.8 mm long; antennae similar, with the same shape and the same relationship between the joints.

Wings tinted slightly more yellowish brownish, appearing darker, the veins however with distinct fuscous borders, especially in middle part of wings, rendering the wings darker and making the costal cell, basal half of first submarginal cell, and almost entire first basal cell dark, and the discoidal and second basal cells with clear streaks in middle; other venational characters as in ♂; halteres very similar.

Legs like those of ♂; hind femora also thickened, but slightly less so, not so distinctly subspindle-shaped, armed below with the usual double row of similar spines (in this case 8–12 in outer row and 8–9 in inner one); front femora however with some distinct, spicule-like or hair-like spines along inner side below; spicules on tibiae longer and more developed than in ♂, and those on hind tibiae distinctly more so.

Genital segments with about 8 relatively slender, yellowish brown to dark or blackish brown spines on each acanthophorite, the apical last one being

more slender or spine-like.

Described from 10 ♂♂, including the holotype, and 4 ♀♀, including the allotype, in the South African Museum.

Length of body: about 14–18 mm (♂♂) and 15–17 mm (♀♀)

Length of wing: about 10,5–12,5 mm (♂♂) and 11–12,5 mm (♀♀)

Distribution

Northern and north-eastern South West Africa: Kungveld: 48 km north of Roooidag Gate (H. D. Brown, 7/4/1970) (1 ♂ holotype, 1 ♀ allotype, 1 ♂ paratype and 1 ♀ paratype); Kungveld: 96 km north-east of Roooidag Gate (H. D. Brown, 8/4/1970) (1 ♂ paratype); 6 km south of Mukambo, Okavango (Okovango) River (H. D. Brown, 17/4/1970) (1 ♂ paratype and 1 ♀ paratype); 30 km west of Kurenkuru (Kuringkuru), Okavango (Okovango) River (H. D. Brown, 16/4/1970) (6 ♂ paratypes); Ovamboland: Border Beacon 24 between South West Africa and Angola (H. D. Brown, 19/4/1970) (1 ♀ paratype).

This species differs from *matetsiensis* Beq. by the slightly darker reddish abdomen, shorter antennae, more slender third antennal joint, distinctly much shorter proboscis, shorter vestiture, comparatively shorter legs, shorter claws, apically less broadly open first posterior cell in wings, and more slender and narrower processes of sternite 9 in ♂.

Genus NAMADYTES Hesse

Namadytes Hesse, 1969: 278.

Namamydas Hesse, 1969: 284 (n.syn.).

The discovery of two additional species of *Namadytes* from South West Africa, described below, and of which one is represented by both sexes, proves without doubt that the ♂ sex of *Namadytes* (unknown at the time of description) is identical generically with the ♂ described by me as *Namamydas*. The latter genus thus falls away as a synonym of *Namadytes*.

The genus *Namadytes*, now represented by 5 known species (2 by ♂♂ only, 2 by ♀♀ only and 1 by both sexes), all from Great Namaqualand in the southern semi-arid half of South West Africa, may be redefined as follows:

Body with the abdomen tending to be pointed apically, more so in ♀♀, also rather markedly broad in basal half in ♀♀, its dorsum on certain tergites infused with yellowish or yellowish ochreous to a variable extent, sometimes mainly or almost entirely yellowish; mesonotum discally sometimes with pale or yellowish streaks; pleurae sometimes also extensively yellowish; tergite and sternite 8 tending to be shortened.

Integument mainly dull, dull and with leathery microsculpture on mesonotum and metanotum; abdomen dulled towards apex, with dense, transverse, 'nadelrissig' puncturation in ♂♂; terminal abdominal segments in ♀♀ rather coarsely, transversely, rugulously striate or grooved; middle part of frons, postalar calli, scutellum to a variable extent, tergite 1, and legs to a variable

extent shining; femora distinctly transversely finely striate.

Vestiture in some ♂♂ fairly long and dense on head, thorax, base of abdomen, and legs, rather sparse in others; in ♀♀ more poorly developed, short and sparse on thorax above, pleurae, and tergites 1 and 2; mesopleuron with some hairs along posterior margin in both sexes, though very sparse in ♀♀; metanotum bare or with scarcely discernible, very short, and fine ones on sides.

Head relatively broad, markedly broad across eyes in ♂♂, broader than across broadest part of thorax; interocular space on vertex very broad, much broader than interocular space on head below, being nearly, or only a little less than, twice distance between antennae and vertex; vertex a little sunk in; eyes comparatively large and convex; antennae (cf. Fig. 3, left and middle; Hesse 1969: 280, 284, figs 15–16) shortish, joint 3 about as long as, or shorter than, rarely longer than, club, the latter elongate pyriform, more dilated beyond middle, its apical sensory area terminal, subtruncate, or truncate, or obliquely crater-like, sometimes appearing sunk in; proboscis much reduced, vestigial, though the structures are still discernible in miniature, the stem being shorter than labellar part; palps minute, not longer than the vestigial proboscis; buccal cavity reduced and shallow.

Wings rather short, not projecting much beyond apex of abdomen, hyaline in ♂♂ and with a feeble milky white sheen, in ♀♀ usually infuscated in middle parts, especially along the veins; alula broad, lobe-like; second submarginal cell usually with a basal appendix; first posterior cell either opening narrowly on costal margin or much narrowed apically and angularly subtending on it, or with a short apical stalk (thus apparently opening on apex of second vein); apex of discoidal cell either meeting posterior veins at a point or with a short stalk.

Abdomen cylindrical in ♂♂, slightly flattened in ♀♀, with only 7 segments clearly visible in ♂♂, segment 8 not, or scarcely, visible, and only so on sides; a projecting appendage, process or lobe (cf. Fig. 3, right AP) on each side between lobe of tergite 8 and sternite 8 (probably arising dorsally from base of sternite 8) present in ♂♂ of some species; bullae comparatively small, smaller in ♀♀, widely separated.

Legs comparatively short, the tarsi, especially front and middle ones, also comparatively short; tibiae slightly curved; hind femora slightly clavately thickened, armed below with a double row of slender spines in apical half beyond middle which become progressively longer towards the apex; spicules on tibiae slender, bristle-like, sometimes very short, the apical ones on hind tibiae much longer than those of other tibiae; basal tarsal joint of hind legs slightly thickened, longer than claw-joint; pulvilli in ♀♀ distinctly reduced, not, or scarcely, extending beyond middle of claws, the latter in ♀♀ also less rapidly curved down apically.

Hypopygium of ♂♂ (cf. Fig. 3) with the combined anal lobes well developed; lateral lobes of tergite 9 only a little produced, only slightly lobe-like or obtuse-angular, not sharply or angularly produced as in some other genera and species,

the hind margins of the lobes with markedly long bristly hairs on sides; lateral lobes of concealed tergite 8 sometimes discernible or projecting; sternite 9 inflated, rounded apically, centrally slightly grooved, not keeled, apically; processes on sides of the sternite slightly curving inwards apically, bluntly rounded apically and directed slightly upwards, the apical half below usually with dense tooth-brush-like hairs; aedeagal apparatus in form of an apically-obliquely-truncated, columnar or triquetrous process in the truncated part of which, resembling the apex of an elephant's trunk, there are the gonoporal structures of the two parallel, contiguous or subcontiguous, phallic tubes, and dorsally (anteriorly) to these the central-rod-like, slightly more projecting epimere (cf. Fig. 3, centre and right; Hesse 1969: fig. 17).

Genital segments in ♀♀ with the last vertical genital segment markedly shortened, the vertical carina shorter than half the length of lower margin of acanthophorite; the latter armed with a row of rather slender spines.

The type-species of this genus is the ♀ of *Namadytes vansonii* Hesse (Hesse 1969: 280) and the typical characters of the ♂ are embodied in the generically synonymous ♂ *Namamydas maculiventris* Hesse (Hesse 1969: 284, 285).

This genus resembles the North African genus *Syllegomydas* Beck. and the South West African representative (subgenus *Notobates* Hesse) of it superficially in the much reduced and vestigial proboscis, vestiture, and wing-venation, but in the ♂ sex it may at once be distinguished by the entirely different aedeagal apparatus. The ♀♀ differ by the distinguishing characters given by me (Hesse 1969: 278, 279), but chiefly by the broader interocular space on vertex, less reduced buccal cavity and proboscis, the less consistently stalked first posterior cell, which, if stalked, is not stalked on second vein but on costal margin, by the much shorter vertical carina on genital segment, and by the more reduced pulvilli.

The five known species may be separated as follows:

- | | | | | | | | | | | | | | | | | |
|------|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------------------------|
| 1(a) | Males | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2 |
| (b) | Females | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 4 |
| 2(a) | Mesonotum and pleurae mainly dark or black; abdomen with more extensive dark or black markings discally and laterally; greater part of femora and at least front and middle tibiae darkened; hind femora distinctly more clavately thickened; pulvilli shorter, falling short of apices of claws; antennal clubs darker or with only apical part paler, yellowish; base of second submarginal cell with a longer appendix; lateral lobes of tergite 9 more obtusely rounded apically; processes of sternite 9 relatively shorter; no projecting lobe on each side from base of sternite 8 discernible; smaller species, about 10–15 mm long, with a wing-length about 7,7–11 mm | | | | | | | | | | | | | | | 3 |
| (b) | Mesonotum with the sides and 2 submedial streaks pale yellowish reddish and greater part of pleurae mainly yellowish; abdomen mainly, or more extensively, yellowish, or with less extensive dark markings, only discally on tergites 1–3; legs entirely or mainly yellowish; hind femora more slender; pulvilli longer, broader, reaching apices of claws; at least apical half of clubs orange yellowish; base of second submarginal cell with a very short appendix; lateral lobes of tergite 9 more sharply angular; processes of sternite 9 longer; a projecting lobe on each side from base of sternite 8 present; larger species, about 17–17,5 mm long, with a wing-length about 12–12,5 mm | | | | | | | | | | | | | | | ♂ <i>pallidus</i> n.sp. |
| 3(a) | Larger species, about 15 mm long, with a wing-length of about 9,5 mm; abdomen above more extensively yellowish, the apical half discally mainly or extensively yellowish; entire | | | | | | | | | | | | | | | |

- hind tibiae yellowish; tarsi mainly yellowish; vestiture distinctly longer and denser, that on head in front not tending to be arranged awning-like in tiers, that on abdomen, especially base, and legs much longer and denser; first posterior cell in wings with a longer apical stalk; lateral lobes or sides of tergite 9 more subangular; processes of sternite 9 longer; aedeagal apparatus thicker, more triquetrous ♂ *maculiventris* (Hesse)

(b) Smaller species, about 10–13 mm long, with a wing-length of about 7.7–11 mm; abdomen above less extensively yellowish, more black being evident, the apical half with yellowish to a variable extent only discally posteriorly and across hind margins of tergites; more than apical half of hind tibiae blackish brown like the rest; middle joints of tarsi tending to be darkened; vestiture distinctly shorter and sparser, long only on head in front where it tends to be arranged awning-like in tiers, that on abdomen and legs distinctly very much shorter; first posterior cell apically subtending angularly on costal margin, or with a very short stalk; sides of tergite 9 more rounded; processes of sternite 9 relatively shorter; aedeagal apparatus much smaller, more columnar ♂ *cimbebasiensis* n.sp.

4(a) Clypeus more yellowish; mesonotum yellowish, with 3 broad, nearly contiguous, black streaks; abdomen more extensively and broadly ochreous yellowish above, including greater parts of tergites 1 and 7, only 8 entirely dark; legs paler, yellowish brown, basal parts of tibiae more extensively yellowish; vestiture sparser, shorter, the metanotum bare, that on legs shorter and sparser; first posterior cell in wings distinctly shortly stalked apically; acanthophorites of last genital segment each with about 6 spines ♀ *cimbebasiensis* n.sp.

(b) Clypeus brownish; mesonotum mainly dark or black, only sides obscurely paler, densely covered with greyish tomentum; leaving only 3 widely-separated dark bare streaks; abdomen above less broadly yellowish and, if extensively yellowish, at least apical half of tergite 1 and tergites 6–8 dark; legs darker, more brownish, only knees yellowish; vestiture slightly denser, longer, the metanotum with some short hairs on sides, hairs on legs distinctly longer, denser; first posterior cell either broadly sessile, subtending angularly, or narrowly open, on costal margin; acanthophorites each with about 7–9 spines . . . 5

5(a) Tergites 3–5 broadly ochreous yellowish discally, to a lesser extent also on 2 discally, central discal part of 6 reddish; hind margins of tergites 1–3 and 4 and 5 yellowish white discally; last tergite more coarsely grooved; antennal joint 3 much shorter, it plus 1 and 2 as long as club, the latter more rapidly thickened from base; proboscis evident only as a small globular labella; infusion in wings less conspicuous along veins; apex of first posterior cell narrowly open; acanthophorites each with about 9 spines; larger species, about 18 mm long ♀ *vansonii* Hesse

(b) Tergites 3–5 yellowish discally only on posterior two-thirds; hind margins of tergites 1–4 and discally on 5 and 6 more whitish; last tergite less coarsely grooved; antennal joint 3 much longer, only a little shorter than club, the latter more gradually thickened to beyond middle; proboscis rudimentary, but with a distinct short stem and labella; infusion in wings more evident in middle part, darker there, more blackish brown along veins; apex of first posterior cell angularly subtending, or sessile, on costal margin; acanthophorites each with about 7 spines; slightly smaller species, about 15 mm long . . . ♀ *prozeskyi* Hesse

***Namadytes maculiventris* (Hesse) n.comb.**

Namamydas maculiventris Hesse, 1969: 285, figs 16–17 (n.syn.).

This species, represented by a unique ♂ from Vioolsdrif in the Richtersveld, was described by me as the type-species of my new genus *Namamydas* which at the time was however represented by the male sex only. The subsequent discovery of a new species of *Namadytes*, represented by both sexes and described below, shows without doubt that this ♂ *Namamydas maculiventris* belongs to the other new genus *Namadytes* described from ♀♀ only a few pages ahead.

Namadytes cimbebasiensis n.sp.

This comparatively smallish new species* from South West Africa, represented by both sexes collected at the same locality and on the same date, shows that there are distinct differences between the ♂ and ♀ as far as the colour of the body, the vestiture, the infusions along the wing-veins, and the length of the pulvilli are concerned and proves without doubt the generic identity of the ♀♀ of *Namadytes* and the ♂♂ of *Namamydas*.

The species is characterized as follows:

Body in ♂ with the head, thorax above, metanotum, pleurae, and basal half, or greater part, of tergite 1 mainly black; discal basal patches on tergites 2-4 (or sometimes 2-7), lateral patches on these segments, sometimes entire segments 5-7 above and below, and medial infusions on ventral sternites 2-4 blackish brown; vestigial proboscis yellowish and lower part of rims of buccal cavity yellowish white; the following parts yellowish: shoulders to a variable extent, extreme sides of mesonotum, postalar calli, hind border of scutellum, pleural part below wing-bases, pteropleuron to a variable extent, metapleural part below halteres, halteres, sides of tergites 1-4 (or 5), and sternites 1-4 (or 5); hind margins of tergites and sternites comparatively broadly more yellowish white; bullae relatively small, blackish, widely separated; legs brownish, the apices of femora, basal parts of middle and hind femora, bases, posterior and apical parts of hind coxae, bases and extreme apices of tibiae, and bases and apices of tarsi yellowish; antennae brownish, articulations of joints 1 and 2, bases and apices of joint 3 and, to a variable extent, apical half or part of clubs yellowish; hypopygium yellowish to pale yellowish brown.

Body in ♀ mainly ochreous yellowish; antennal joints below, part of face below antennae, and the clypeus also yellowish; mesonotum with 3 broad, almost contiguous, posteriorly-abbreviated, black streaks; pleurae mainly yellowish, with slight brownish infusions on meso-, sterno-, and hypopleurae, and sternal parts in front of coxae; metanotum blackish brown; base of tergite 1, the transverse groove across base of 2, patches on sides of tergites 2-7, and entire tergite 8 also blackish brown, the extreme lateral margins of these tergites being darker, almost black; venter mainly yellowish except for some slight brownish infusions along middle; hind margins of tergites broadly yellowish white; bullae smaller than in ♂, blackish; lobes below genital segment yellowish; legs almost entirely pale yellowish, only the coxae in front, subapical parts of front and middle femora above, at least apical half of hind femora above, apical half of hind tibiae, and middle parts of rest of tibiae with a slight touch of brownish.

Integument with the middle part of frons, face and clypeus shining; mesonotum and metanotum dull, leathery; pteropleuron somewhat shining; abdomen above with the basal parts and especially basal transverse groove across tergite 2 also shining, rest of abdomen in ♂ with fine 'nadelrissig' puncturation, in

* As coming from 'Cimbebasia' an old name for South West Africa.

♀ smoother and somewhat shining, with a lateral intramarginal streak of fairly coarse rugose puncturation along sides of tergites 2-5, coarser in ♀; tergites 7 and 8 in ♀ transversely grooved, the latter more coarsely so; legs subshining, the femora finely transversely striate.

Vestiture denser and longer in ♂, in ♀ very sparse, absent from greater part of abdomen, that on head in front in ♂ long and dense, sericeous white, arranged awning-like across vertex, sides of frons, above antennae, and across clypeus, in ♀ arranged similarly, but very much sparser, the sides of frons and face with more evident, denser, grey tomentum; hairs on mesonotum sericeous white, arranged more or less in 4 streaks, longer, denser, more evident in front half and medially posteriorly, much shorter and sparser in ♀; hairs on pleurae sparse in both sexes, more so in ♀, whitish, present only on mesopleuron posteriorly, on pteropleuron, part of metapleuron anterior to halteres, and on sternum in front of posterior coxae, and very sparse in ♀; hairs on abdomen of ♂ fairly dense, but short, long and white on sides of tergite 1, fine and short, decumbent, located in the fine puncturation, gleaming more sericeous yellowish, slightly longer on lateral lobes of tergite 9 and on anal lobes, sparse and short on venter, but as dense and as long in puncturation on sternites 5-7 as above; hairs on abdomen in ♀ with a few sparse longish ones on sides of tergite 1, very short and sparse and almost absent from rest of tergites except for sparse,

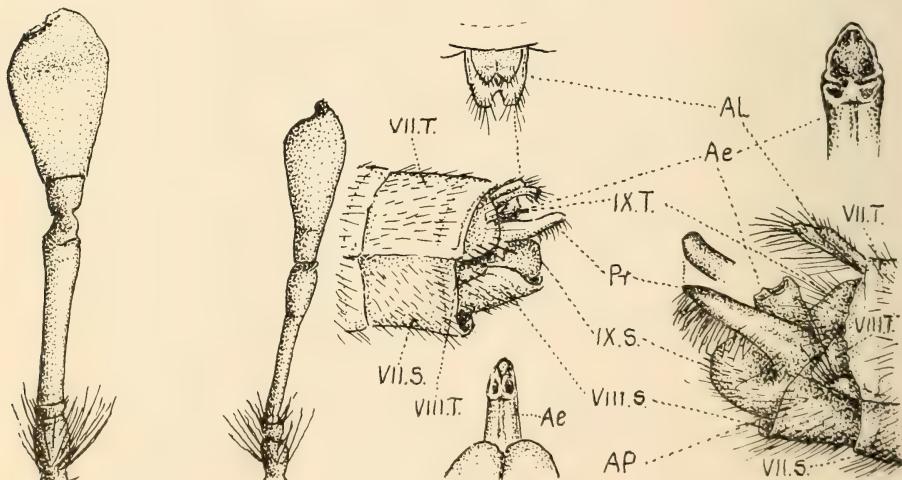


Fig. 3.

Left: Inner view of right antenna of ♂ *Namadytes pallidus* n.sp. Centre: Right antenna of ♂ *Namadytes cimbebasiensis* n.sp. (left); hypopygial structures (centre) of ♂ of same species, with dorsal view of anal lobes (top) and much enlarged aedeagal apparatus (below). Right: Hypopygial structures, from right side, of ♂ *Namadytes pallidus* n.sp., with enlarged posterior view of the aedeagal apparatus (top).

(Ae = aedeagal apparatus; AL = anal lobes; AP = appendage or lobe of sternite 8; IX.S. = sternite 9; IX.T. = lateral lobe or tergite 9; Pr = process of sternite 9; VII.S. = sternite 7; VII.T. = tergite 7; VIII.S. = sternite 8; VIII.T. = exposed lateral lobe of hidden tergite 8.)

short, reversed, slightly golden yellow ones on tergites 6 and 7, and sparse, but slightly longer, ones on 8; venter in ♀ bare, but with longer yellowish hairs on lobes below acanthophorites; hairs on legs comparatively short, gleaming sericeous yellowish in certain lights, sparser in ♀, with the spines and spicules yellowish.

Head with the interocular space on vertex broad, about as wide as distance from apex of ocellar tubercle to apex of clypeus, appearing wider in ♀ due to the smaller and less convex eyes; interocular space on head below much narrower, the inner margins of eyes converging below; antennae (cf. Fig. 3, second from left) in ♂ about as long as, or a little longer than, mesonotum, distinctly much shorter than mesonotum in ♀; joint 1 about, or a little more than, twice length of 2, not much thickened; joint 3 shorter than club, the latter elongate pyriform, with a distinct bottle-necked base, broadest beyond middle, obliquely subtruncate apically, the sensory area being fairly large; clypeus roundly convex, more so in ♀; buccal cavity shallow, apparently slightly broader in ♀; proboscis vestigial, rudimentary, ending in two small, rounded lobes and a median, dorsal, finger-like lobe; palps minute, scarcely evident.

Wings not projecting, or not projecting much, beyond apex of abdomen, the membrane markedly wrinkled, hyaline in ♂, but with a slight milky whitish tint in certain lights; veins yellowish brown, but costal and subcostal veins and those at base of wings yellowish; veins in middle part of wings in ♀ bordered with fuscous; second submarginal cell with an appendix basally; apex of first posterior cell with a very short stalk or angularly subtending on costal margin; discoidal cell rather acute apically, meeting first and third posterior cells at a point (or third posterior cell very shortly stalked apically); halteres yellowish white, sometimes slightly darkened above near inner apical angle.

Legs relatively rather short, slightly longer in ♀; hind femora clavately thickened, with a double row of yellowish spines below in apical half, beginning at about just before middle, 5–6 in outer row and 5–6 (more often 5) in inner row, on slight tubercles, those subapically at thickest part of femora the longest; tibiae in ♂ slightly curved, but hind ones in ♀ substraight, the spicules on tibiae short, except apical ones (spurs) and especially hind ones; tarsi relatively short, the hind ones longer, the tarsi in ♀ appearing much shorter owing to the slightly longer tibiae; basal joint of hind tarsi longer than claw-joint, much longer in ♀, the basal joints of rest of tarsi shorter than claw-joints; claws more rapidly bent down apically in ♂ than in ♀; pulvilli much reduced in ♀, scarcely, or not, reaching middle of claws.

Hypopygium of ♂ like that of *maculiventris* (cf. Fig. 3, centre; Hesse 1969: 286, fig. 17), with the sides of tergite 9 not projecting much, broadly rounded apically; no projecting lobe on each side between lateral lobe of tergite 8 and sternite 8 discernible; processes of sternite 9 bent slightly upwards near apex, their apices curving slightly inwards; aedeagal apparatus more slender than that of *maculiventris*, more columnar.

Genital segments of ♀ with 6 golden yellow spines on each acanthophorite.

From 3 ♂♂, including the ♂ holotype, and 1 ♀ allotype in the South African Museum.

Length of body: about 10–13 mm

Length of wing: about 7.7–11 mm

Distribution

South West Africa: Excelsior, No 127, Maltahöhe District (H. D. Brown, 7/8/1969).

The ♂ of this species is very near the ♂ of *maculiventris* (Hesse), but is smaller, with less extensive yellowish on the abdomen above, with distinctly less dense and shorter vestiture on body and legs, with the lateral lobes of tergite 9 more rounded and not so subangular, and with the aedeagal apparatus more columnar and more slender.

The ♀ differs from both the ♀♀ of *vansoni* Hesse and *prozeskyi* Hesse in its more extensively and broadly ochreous yellowish abdomen above, its paler legs, shorter and sparser vestiture, bare metanotum, apically shortly-stalked first posterior cell, and the fewer spines, only 6, on each acanthophorite.

Namadytes pallidus n.sp.

This mainly yellowish species, represented by the ♂ sex only, is characterized as follows:

Body mainly ochreous yellow; sides of face and head below dark reddish brown; frons, vertex, occipital part, and eyes black; shoulders pale yellowish white; the following parts dark or black: three broad, longitudinal streaks on mesonotum, not reaching posterior margin and lateral ones not extending to shoulders, a posterior, discal infusion on scutellum, an infusion below anterior spiracle on pleurae, continuous towards sternum with a large infusion on lower half of sternopleuron, a spot or infusion in middle of mesopleuron, an infusion on lower half of hypopleural part, hinder part of metanotum, basal part of tergite 1, basal transverse groove across tergite 2, a basal, discal, \cap -shaped mark on tergite 2, the bullae (which are widely separated), and a small, basal, discal spot on tergite 3; sides of abdomen, especially on tergites 4–7, intramarginally with a faint brownish streak in one specimen; hind margins of tergites and to a certain extent those of sternites fairly broadly whitish; antennae with joints 1 and 2 yellowish brown, joint 3 and basal part, or half, of club brownish, rest of club orange yellowish, and the junctions between joints and extreme base and apex of joint 3 yellowish; hypopygial parts yellowish like rest of abdomen; legs almost entirely pale yellowish, the front and middle femora infused with brownish to a variable extent, and apices of claws black.

Integument with the central and ocellar part of frons shining; that of mesonotum and metanotum dull and leathery; scutellum more or less shining; pleurae dull, with leathery microtexture; abdomen above subshining with fine, setiferous, 'nadelrissig' puncturation; venter more smooth and shining;

legs more or less shining, finely transversely striate, especially femora.

Vestiture fairly long and dense, about as long and dense on anterior part as in *maculiventris*, entirely snow white; that on head in front and on clypeus very dense, the sides of face also with greyish tomentum; that on mesonotum even slightly denser than in *maculiventris*, leaving 3 broad, bare, longitudinal streaks, the lateral ones not reaching shoulders; hairs on sides of mesonotum and medially in front of scutellum longer and denser than discal ones; metanotum entirely bare; hairs on pleurae, where present on propleuron, along upper and hind margins of mesopleuron, on metapleural part in front of and below halteres, and on hind coxae, long and dense; hairs on tergite 1, especially laterally, to a slightly lesser extent those on tergite 2 (more so laterally), and to a much lesser extent sides of 3 also long and dense; decumbent hairs in puncturations on rest of abdomen above much shorter, but also dense; those on anal lobes and projecting sides of tergite 9 longer again; hairs on venter sparse; those on legs fairly dense, sericeous white, those on dorsal surfaces of femora markedly long; spines on femora and spicules on tibiae pale yellowish white.

Head with the interocular space on vertex about subequal in width to distance between top of ocellar tubercle to anterior rim of clypeus and much broader than space between eyes on head below which is however relatively proportionally broader than in *maculiventris*; vertex slightly sunk in; antennae (cf. Fig. 3, left) much shorter than mesonotum, joint 1 thickened, quite three times as long as 2, joint 3 rather stoutish, rod-like, much shorter than club; latter a little shorter than rest of joints combined, elongate pyriform, broadest beyond middle, its base slightly constricted bottle-neck-like and articulating part between it and apex of joint 3 rather long, the sensory area at apex of club slightly obliquely truncate; clypeus prominently roundly convex; buccal cavity shallow; proboscis much reduced, rudimentary, much shorter than antennal joint 1, evident as a short base and a short, or much shorter, bilobate labellar part; palps comparatively less reduced than in the other species and in one specimen quite as long as the reduced proboscis.

Wings just about reaching apex of abdomen, hyaline, with a slight milky white tint in certain lights, especially along costal half in basal half; membrane distinctly wrinkled; veins very pale yellowish white, those between first submarginal and first basal cells, posterior vein of first, third posterior and anal cells appearing darker in certain lights; second submarginal cell with a very short appendix basally; apex of first posterior cell with a very short stalk to costal margin; acute apex of discoidal cell with a short stalk of variable length; halteres whitish.

Legs relatively slender, more so than in the other known species; hind femora only very slightly subclavately thickened, armed below with a double row of short spines on slight tubercles (2 or 3 in outer row and 2-4 in inner one) in more or less apical third, the inner row beginning before the outer one; tibiae slightly curved, with bristle-like spicules, only the apical ones (spurs) being stoutish; tarsi with the hind ones in ♂, as in the ♂♂ of the other species

of the genus, longer than the rest, its basal joint longer than the claw-joint; claws rapidly bent downwards apically and the pulvilli well developed, broad, extending to apices of claws.

Hypopygium (cf. Fig. 3, right) with the anal lobes well developed; projecting sides of tergite 9 slightly obtusangularly prominent apically; a distinct projecting lobe-like appendage or process present on each side between lateral lobe of concealed tergite 8 and base of sternite 8 (cf. Fig. 3, right AP); sternite 9 inflated and lobe-like, rounded apically, its processes, in side view, comparatively less slender apicalwards and more rapidly narrowed from base below than in the case of *maculiventris* (cf. Hesse 1969: 286, fig. 17), also comparatively shorter and, in dorsal view, distinctly broader; aedeagal apparatus very similar to that of *maculiventris*, only stouter.

From 2 ♂ specimens (holotype and paratype) in the South African Museum.

Length of body: about 17–17.5 mm

Length of wing: about 12–12.5 mm

Distribution

South West Africa: Great Namaqualand: 48 km south-east of Keetmanshoop (J. G. Rozen and E. Martinez, 30/10/1968).

This species is very near *maculiventris* (Hesse), but, apart from the differences already mentioned in the text, may be easily distinguished by its larger size, extensively yellowish body, pleurae, and legs, its much longer wings, more slender and longer legs, and presence of a distinct projecting lobe-like process posteriorly between lateral lobe of concealed tergite 8 and base of sternite 8.

Other species of NAMADYTES

The other two known species of *Namadytes*, described from South West Africa, are *Namadytes vansonii* Hesse (Hesse 1969: 280, fig. 15) and *Namadytes prozeskyi* Hesse (Hesse 1969: 282) and both known from the ♀ sex only.

Halterorchini n.tribe

The new species of Mydaidae acquired by the South African Museum and those submitted to me for description since the publication of my revision of this family as represented in Southern Africa in 1969, and more especially representatives of the ♀♀ of two of the species described previously or now as new genera in this paper from the male sex only, necessitate a new approach to the classification of the Mydaidae.

The genus *Halterorchis* Bezzi, based on ♀♀ only, occupies an anomalous position among the genera of the subfamily Syllegomydinae and in 1969 (Hesse: 10, 17, 287) it was provisionally referred to a new tribe Syllegomydaini which at the time was erected to accommodate a long list of genera. At that time the ♀♀ of *Halterorchis* were the only ones with a reduced number of normal

abdominal segments, namely only 7, the eighth being modified to form a distinct hood over the genital segment (modified segment 9, with its acanthophorites) and sternite 8 is also modified, partially concealed, not scoop-like. Both the ♀ of a new species of *Nothomydas* Hesse and that of the new genus *Namibimydas*, described in this paper, agree with the ♀♀ of *Halterorchis* in having the same anomalous type of abdomen and modified tergite 8 and sternite 8. It is quite evident that this modification of the tergite and sternite is a constant character of group value and, as the ♂♂, not only of *Nothomydas* but also of the other two new genera *Mimadelphus* and *Namibimydas*, described below, also have only 7 normal tergites and sternites (or sternite 7 sometimes concealed), the eighth being entirely concealed and not discernible or even half concealed, this abdominal anomaly, together with certain other secondary characters which all these genera share, should be considered as of distinct tribal value.

A new tribe *Halterorchini* is therefore proposed to accommodate the genera *Halterorchis* Bezzi (1924), *Nothomydas* Hesse (1969), *Mimadelphus* n.gen. and *Namibimydas* n.gen.

This new tribe of the Syllegomydinae is characterized as follows:

Abdomen of both ♂♂ and ♀♀ with only 7 normal, unmodified tergites and sternites, the eighth in ♂♂ being entirely concealed and not discernible, or with only the lateral apical part exposed as a lobe-like process; a projecting process or lobe connected with the concealed sternite 8 or tergite 8 may be present in some ♂♂ (cf. Fig. 6, AP.); abdomen in ♀♀ distinctly modified when compared with the usual 8 normal, not greatly-modified, segments in the ♀♀ and the half concealed and discernible eighth segment in the ♂♂ of the other 3 tribes; tergite 8 in known ♀♀ more distinctly modified in the form of a dorsal hood over the spine-bearing acanthophorites and sternite 8 half concealed under sternite 7, its hind margin or hinder part (cf. Fig. 7, right) indented or emarginate V-like, not entirely exposed and scoop-like as in ♀♀ of the other tribes; tergite 9 in ♂♂ either produced apically on each side into a curved, flattened, dorsal process which most likely participates in copulation (cf. Figs 4, 6; Hesse 1969: fig. 18 B), or the tergite is divided into 2 lobes from the apex of each of which there extends ventrally a flattened sheet which is fused or continuous with the dorsal process on each side of sternite 9 (cf. Fig. 6); tergite 9 in ♀♀, as in genera of the two tribes Syllegomydinae and Cephalocerini, constitutes the genital segment or central carinate ridge and spine-bearing acanthophorites; sternite 9 in ♂♂ (cf. Figs 4, 6) either navicular, hollowed scoop-like, or very much enlarged and shell-shaped, indented or sulcate apically, with the edges of the indentation on each side raised carinately and externally to this the apical part is produced on each side into a flattened, curved, bluntly-pointed process, prong or a curved spine (cf. Figs 4, 6; Hesse 1969: fig. 18 B); aedeagal apparatus in ♂♂, as far as this is discernible, either rod-like, in form of a forked rod, or as a forwardly-curved process.

Other supplementary characters shared by these genera are:

Head with relatively broad to markedly broad interocular space on vertex;

antennae (cf. Figs 4, 5) comparatively short and stoutish, with much inflated, pyriform clubs which are longer than the relatively short third antennal joints; proboscis vestigial or long and very slender.

Vestiture with the hairs markedly granulated; tomentum on head, thorax, and abdomen, especially on latter, in known ♀♀ extensively developed.

Wings comparatively narrow, but with an *Afroleptomydas*-type of venation.

Legs comparatively hairy, with the apical spicules or spurs of tibiae long or markedly long.

The four known genera may be separated as follows:

♂♂

- 1(a) Proboscis rudimentary or vestigial; processes of sternite 9 more slender, spine-like; lateral processes of tergite 9 shorter, lobe-like; body above with dense, woolly or vellose vestiture *Mimadelphus* n.gen. 2
- (b) Proboscis well developed, long to elongate, slender, with the labella broad or spear-blade-shaped; processes of sternite 9 broader, more flattened, strap-like; lateral processes of tergite 9 either longer, more straplike or in form of a ventral, downwardly-directed, flattened sclerite fused to processes of sternite 9; body above only hairy or densely hairy, not densely woolly or fur-like 2
- 2(a) Sternite 9 of hypopygial part much smaller, navicular, its processes downwardly curved, flattened, spine-like; lateral processes of tergite 9 projecting, curved, strap-like; sternite 7 normally developed; concealed segment 8 without a visible projecting, lobe-like appendage on each side; legs comparatively shorter, with the front and middle trochanters small, normal; apical spicules of tibiae and especially those of tarsi, not markedly elongate; smaller, less densely hairy forms *Nothomydas* Hesse
- (b) Hypopygial part greatly developed; sternite 9 enormously developed, *Argonauta*-shell-shaped, much laterally compressed, keeled below, its processes broad, curved inwards and then slightly outwards; lateral processes of tergite 9 in form a broadened, downwardly-extending sheet united with inner part of processes of sternite 9; sternite 7 almost concealed, pushed far forwards under sternite 6 by the greatly developed sternite 9; concealed segment 8 with a distinct projecting lobe-like appendage on each side; legs comparatively much longer, the front and middle trochanters with a flattened lobe-like, basal extension; apical spicules of tibiae and those of tarsi conspicuously and markedly elongated; larger, very densely-haired Asilid-like forms *Namibimydas* n.gen. 2

♀♀

- 1(a) Tergite 9 with the raised, central, carinate ridge very short, less elevated, the acanthophorites smaller, with fewer spines, only 5 or 6, on each side, the spines slender, rod-like; trochanters of front and middle legs small, without a lobe-like extension basally; vestiture on body and legs less developed, less woolly, the hairs on abdomen above shorter and sparser, directed forwards on most of the segments, and the tomentum denser; wings much narrower; smaller forms, less than 20 mm long 2
- (b) Tergite 9 with the raised central carinate ridge longer, more elevated, arch-like, the acanthophorites with more than 6 (about 8) spines on each side, the spines much broader, shoe-horn-shaped and hollowed above; trochanters of front and middle legs larger, with a distinct, flattened, lobe-like extension basally; vestiture on body and legs distinctly much denser, more woolly, that on abdomen above longer and denser and only that on last two segments directed forwards, and the tomentum relatively less dense; wings broader; larger forms, about 21–24 mm long *Namibimydas* n.gen. 2
- 2(a) Proboscis rudimentary, vestigial; half concealed sternite 8 appearing carinate or sulcate centrally, its hind margin more shallowly emarginate or indented V-shaped; hairs on head sparser, coarser, those on mesonotum leaving 3 broad, entirely bare, tomented streaks, abdomen above with a pattern of crescent- or └-shaped markings; bullae small or minute *Halterorchis* Bezzi
- (b) Proboscis well developed, slender, elongate, spear-shaped; half concealed sternite 8 more broadly and deeply indented or emarginate (V-shaped) posteriorly, not appearing centrally carinate or longitudinally sulcate; hairs on head distinctly denser and finer, those

on mesonotum denser, finer, leaving narrower, not entirely bare, streaks; abdomen above with finer, slightly denser, short hairs, and only partly densely tomented, without a peculiar pattern; bullae larger *Nothomydas* Hesse

Genus *NOOTHOMYDAS* Hesse

Nothomydas Hesse, 1969: 290

This genus, which is now placed in the new tribe Halterorchini and of which the original description was based on a single ♂ specimen from the South West African side of the Orange River at Vioolsdrif, has since the publication of the description, been augmented by representatives of a closely related new species. The latter, composed of ♂♂ and a ♀, was collected at Port Nolloth in Namaqualand. To complete the description of the genus, the diagnostic characters of the ♀ representative, as well as some supplementary characters of the ♂♂ of the new species, are as follows:

Head much broader than thorax; interocular space on vertex moderately broad, broader than interocular space on head below, in ♂ quite $1\frac{1}{2}$ – $1\frac{3}{4}$ as wide, in ♀ the space below is relatively broader relative to the interocular space above; eyes markedly large in ♂, markedly convexly globular, smaller in ♀; antennae as described and figured in 1969 (Hesse: 290, 294, fig. 18 B), but clubs in known ♀ more globular; central ocellar ridge on frons prominent and shining in both sexes; clypeus short, convex; buccal cavity relatively deep, in both sexes; rest of cephalic structures as described in 1969.

Wings comparatively short in both sexes, not reaching tip of abdomen, comparatively narrow; first posterior cell either narrowly opening on second vein or more broadly so and thus appearing very shortly stalked or sessile on costal margin; rest of wing characters as described in 1969 for the type-species.

Abdomen of ♂♂ as described for the type-species, but the modified lobe-like extension on each side of the partly hidden tergite 9 either strap-like or narrower and spine-like; abdomen in known ♀ broader, more dorso-ventrally depressed, also with 7 normal tergites and sternites, but partly hidden tergite 8 hoodlike over genital segment (tergite 9), and sternite 8, as in ♀♀ of the other Halterorchini, partly hidden, its hinder part indented V-shaped, the sides or limbs of the V somewhat inflated.

Hypopygium of ♂♂ as described and figured for the type-species in 1969 (Hesse: 293, fig. 18 B).

Genital segment, or modified tergite 9, of ♀ as described for ♀♀ of Halterorchini above, with a short, raised, central, carinate ridge and a spine-bearing acanthophorite on each side, and medially below these well-developed anal lobes.

Legs relatively short and as described for the genus in 1969, but front and middle femora with or without fine, bristle-like spines along inner surfaces below; front and middle tibiae with or without short, fine, bristle-like spicules, more distinctly present in ♀; hind tibiae with a row of spicules along outer part below, these in ♀ longer and more strongly developed; crown of spicules at

apices of tibiae rather markedly long, especially the hind ones; spicules on tarsi, especially on hind ones, also rather long; claws as described for type-species, but pulvilli sometimes narrower.

Integument of head with the central frontal ridge, head below and to a certain extent clypeus shining; pleurae either entirely shining or in part dull; integument of abdomen either mainly shining above or mainly dull in ♂♂, dull discally above in ♀, in ♂♂ finely setiferously punctured above; integument of rest of anatomy as described in 1969.

Vestiture in ♂♂ as described for ♂ of type-species, but in known ♀ shorter and sparser on front half of body, and fine hairs on abdomen above directed apicalwards on tergites 2-7 and sternites 3-7, those on venter much shorter and sparser than in ♂♂; hairs on legs either short or long and dense, especially on front and middle ones, slightly less so in known ♀, otherwise as described for the type-species in 1969.

From other Halterorchini this genus differs by the characters given in the key to the known genera.

The type-species is *Nothomydas gariepinus* Hesse and the other species is *Nothomydas namaquensis* n.sp. described below.

Nothomydas namaquensis n.sp.

This species, which was collected on the coast more to the south of the Orange River in Namaqualand, is very near the type-species *gariepinus* from which it differs in the following respects:

Body mainly black in ♂, in ♂ *gariepinus* the postalar calli, abdomen above, and to a variable extent the pleurae are more obscurely reddish brown; ♀ of new species with the sides of mesonotum, humeral region, 2 submedial, discal, posteriorly-abbreviated, narrow streaks, the postalar calli, and discal part of scutellum yellowish brown, the pleural parts, metanotum, tergites 1 and 2, discal parts of 3 and 4, and venter to a variable extent also yellowish brown to reddish brown; narrow yellowish white hind margins of tergites and sternites in ♂ more sharply defined than in *gariepinus*; humeral tubercles in ♂ dark, more yellowish in ♀, markedly tomented greyish white in both sexes; antennae in ♂ of type-species more yellowish brown, in ♂ of new species darker brown to blackish brown, paler yellowish brown in ♀; legs in ♂ of type-species yellowish brown, the front and middle femora appearing dark above, and tibiae and tarsi more yellowish, in ♂ of new species the legs are darker brownish to blackish brown, and slightly paler, more yellowish brown in ♀.

Integument as described for the genus; that of abdomen in ♂ more extensively shining than in ♂ of type-species, the dull, to a variable extent greyish-white-tomented parts less extensive, the hinder half of abdomen tending to be more shining, the abdomen above, apart from setiferous puncturation, also more finely transversely striated; in ♀ greater discal parts of tergites to tergite 5 dull and greyish white tomented, the sides more coarsely transversely striated, and intramarginal, longitudinal depression along tergites 2-5 rugulose; legs,

especially femora, distinctly finely transversely striated in both sexes, and hind ones more coarsely so basally and apically and slightly more so than in type-species.

Vestiture in ♂ distinctly longer and denser, but also mainly white on greater part of head, body and legs; that on head distinctly much longer and denser on vertex, behind antennae, on clypeus, and sides of buccal cavity, that on vertex and frons with a slight yellowish tint in certain lights, that on occiput and head below denser than in type-species; dense snow-white hairs along notopleural part, posterior margin of mesopleuron, pteropleuron and metapleural part as dense, but slightly longer; dense white ones on sides of tergite 1 and sides basally of 2 also slightly longer, appearing slightly more creamy yellowish in certain lights; fine, short, decumbent hairs in small punctures on abdomen above distinctly darker, more blackish, not so gleaming sericeous yellowish, and the longer ones along sides of abdomen above also darker, more brownish; hairs on venter very slightly denser than in type-species, darker, gleaming more brownish or blackish brown, and those on hypopygium as long and as dense, but gleaming more brownish; coxae, as in the type-species, mainly smooth below, but with the longish white hairs on sides of hind coxae denser; hairs on legs, especially on femora above, and more especially front and middle ones, conspicuously longer and denser, but also snow white, those on hind femora above with more long ones than in type-species, composed of whitish and dark ones, and those below also denser, sometimes gleaming slightly more yellowish brown; hairs on tibiae, especially front and middle ones, also much longer and denser, also snow white, those on hind tibiae with more numerous long ones along inner aspect, and rest of short hairs on hind tibiae distinctly darker, more brownish or blackish brown.

Vestiture in ♀ also mainly snow white, slightly shorter than in ♂, but also long and dense on head, humeral tubercles, notopleural part, hind margin of mesopleuron, on pteropleuron, metapleural part, and sides of tergite 1; fine, short, decumbent hairs in small punctures on abdomen above from tergite 2 apicalwards sparser than in ♂, directed forwards and gleaming pale sericeous yellowish or whitish; hairs on venter also sparser, gleaming more sericeous whitish and directed forwards on sternites 3-7; hairs on legs distinctly less dense, the long ones sparser, and all the hairs on femora and tibiae gleaming sericeous whitish; tomentum in ♀ denser, greyish white, more extensively present, especially on head, humeral tubercles, metanotum, ptero- and metapleuræ, hinder part of hypopleuron, and broadly and conspicuously on abdomen discally above.

Head with the interocular space on vertex comparatively broader than in type-species, as 7:6, and space on head below proportionally also broader, the interocular space on head below in ♀ relatively broader than in ♂, as 5:4; antennae proportionally shorter than in *gariepinus*, slightly shorter in ♀ than in ♂, shorter than width of interocular space on vertex in both sexes, slightly longer than this width in the type-species, with the joints proportionally also

shorter than in the type-species, the inflated club, apart from its apical process, less truncated apically, the process itself more conically prominent; proboscis, though slender and similarly shaped (cf. Hesse 1969: fig. 18 B, top) distinctly much shorter, relatively shorter in ♀ than in ♂, only about 2–2, 4 mm long (as against 3 mm in type-species), with the labella slightly more rounded apically in ♂ than in ♀; palps distinctly shorter and thicker than in type-species.

Wings clear hyaline as in the type-species; veins yellowish brown to brownish; second submarginal cell without any appendix; first posterior cell broader apically than in type-species, not sharply narrowed, more angularly subtending, or only shortly stalked, on costal margin, not so distinctly stalked apically as in type-species; axillary lobe relatively narrower; knobs of halteres slightly darker and darker in ♂ than in ♀.

Legs proportionally much shorter, the tibiae also curved, but basal part of hind femora slightly more curved; front femora without any distinct spines below (in ♂ of type-species there are a few slender spines); hind femora in ♂ with fewer and shorter spines below, only about 2 or 3 distinct ones in an apical outer row and 2 in the apical inner row, but in ♀ with 2 or 3 apically on inner aspect and 5 or 6 along outer aspect from about middle; spicules on hind tibiae in ♂ shorter than in ♂ of the type-species, in ♀ longer and stouter than in ♂; tarsi proportionally much shorter, the hind ones shorter, stouter and thicker in ♂ than in ♀, its basal joint proportionally longer; claws proportionally much shorter than in type-species, the pulvilli narrower and apparently slightly shorter, more so in ♀.

Hypopygium of ♂ similar to that of the ♂ of type-species (cf. Hesse 1969: fig. 18 B), but differs in having the curved, modified lobes or extensions of tergite 9 distinctly shorter, slightly narrower, less broadly strap-like, and with the hind margin of the truncated apex even more incised or emarginate; curved prongs or processes of sternite 9 comparatively shorter, more or less subequal in length (from basal bend to apex in side view) to dorsal length of tergite 7 (in type-species it is distinctly longer than tergite 7).

Genital segments of ♀ as described for the genus, with 5 detectable, slender, reddish golden spines on each acanthophorite, the third from base appearing longer, and the last two more slender; hind margin of sternite 8 indented U-shaped; tergite 8 with separated, setiferous punctures, and exposed sides of the sternite transversely substriate.

From 1 ♂ holotype, 4 ♂ paratypes, and 1 ♀ allotype in the South African Museum.

Length of body: about 9–10 mm

Length of wing: about 5,5–7 mm

Distribution

Namaqualand: Port Nolloth (South African Museum Expedition, October 1967).

MIMADELPHUS n.gen.

A single ♂ specimen from South West Africa submitted to me is referable to the new tribe Halterochini and is very near and in the same category as the genus *Nothomydas*. As certain, often slight, morphological differences, such as antennal characters, reduction of the proboscis, differences in venational characters of the wings, the degree of the development of the vestiture, and differences and anomalies in the structure of the genital structures of the ♂♂, have been found to differentiate genera in the Mydaidae, the occurrence of such differences in the ♂ specimen concerned points to a distinct and separate generic status for it.

The ♂ specimen of this new genus differs from ♂♂ of *Nothomydas* s. str. in having a much reduced and rudimentary proboscis, more deeply sunk in vertex, very much denser, fur-like vestiture on body, sparser and shorter hairs on each side just behind antennae, absence of hairs along hind border of mesopleuron, hairs on mesonotum separated by 3 distinct, longitudinal, bare streaks, very much shorter anal lobes, shorter, curved, lobe-like extensions of tergite 9 (cf. Fig. 4), longer, navicular sternite 9 with its longer, more slender, sharply-pointed, spine-like processes, and a very much smaller, shorter, aedeagal, rod-like structure which is not bifid or forked apically.

The probability that this ♂ may represent the unknown ♂ of *Halterorchis* Bezzi, which was described from the ♀ only and which also has a vestigial, or much reduced, proboscis and no hairs across hind border of the mesopleuron, is not excluded. The fact that antennal joint 3 is much longer, the alula of wings is much larger and more lobe-like, the third posterior cell is much more acute apically and its posterior vein more in line with that of first posterior cell, and the legs are proportionally shorter, excludes it from *Halterorchis*.

The type-species of this new genus is *Mimadelphus vellosus* n.sp.

***Mimadelphus vellosus* n.sp.**

Body mainly black; antennae pale yellowish brown, the apex of joint 3 and apical part of clubs darker, more blackish brown; clypeus showing brownish through the hairs; buccal cavity and vestigial proboscis pale yellowish brown; following parts also yellowish brown: shoulders, postalar calli, hind border of mesopleuron, area below wing-bases, including most of pteropleuron, sutural parts between sterno- and hypopleurae, sides broadly of tergite 1, extreme sides of tergite 2, to a more obscure extent extreme sides of rest of tergites, and genital structures; sides of tergites 2–7 broadly and venter slightly more reddish brown; hind margins of tergites on sides more yellowish; sutures between tergites 1 and 2 and 2 and 3 more reddish; bullae shining black; legs with the coxae dark brownish, their apical parts more yellowish, the femora yellowish brown, darker above, subapically, paler below and apically, the tibiae more yellowish, hind ones darker apically, the tarsi brownish above, more yellowish below; claws yellowish, black-tipped.

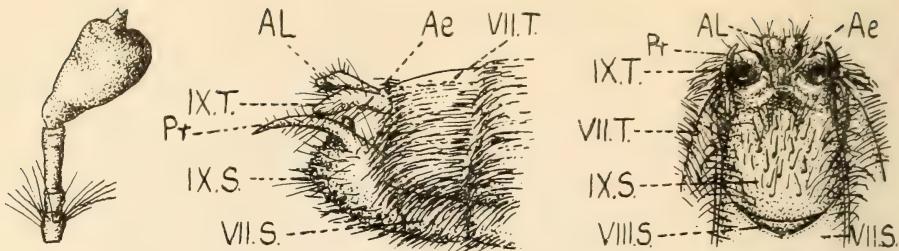


Fig. 4.

Left: Right antenna of ♂ *Mimadelphus vellosus* n.gen. et n.sp. Middle: Side view of apex of abdomen and hypopygium of same species.

Right: Ventro-posterior view of hypopygial structures. (Ae = aedeagus; AL = anal lobes; IX.S. = sternite 9; IX.T. = lateral lobe of tergite 9; Pr = process of sternite 9; VII.S. = sternite 7; VII.T. = tergite 7; VIII.S. = part of hidden sternite 8.)

Integument of central frontal part, clypeus, greater part of pleurae, hinder part of scutellum, sutural parts between tergites 1 and 2, sides of abdomen broadly, venter, and legs shining; mesonotum duller, with fine, microscopical, leathery texture; metanotum dull, and a broad, central, dorsal, partially-bare and partly dark-haired, black streak on abdomen above also dull.

Vestiture on head and body above dense, fur-like, vellose, reminiscent of that of the genus *Agaperemius* Hesse; that on sides of frons, clypeus and sides of face very dense, long, directed downwards, snow white; sides of frons anteriorly also with whitish tomentum; hairs on frons on sides medially just behind antennae sparser than in *Nothomydas*, erect and white; those on vertex anteriorly erect, white, and a dense cluster on each side of occipital part partly on vertex dense, white, directed more inwards and backwards; hairs discally on mesonotum not very dense, very slightly pale sericeous yellowish, arranged in 2 rows in anterior half, separated by a central, bare streak and by a sublateral, anteriorly-abbreviated, bare streak on each side, these 3 streaks coalescing behind middle to form a broad, discal, bare area; hairs on sides of mesonotum and on shoulders very dense, snow white, becoming sparser above wing-bases and across base of mesonotum; scutellum with 2 backwardly-directed, snow white tufts; metanotum with greyish white tomentum and no hairs; pleurae mainly bare, the hinder part of pteropleuron and metapleural part with snow white hairs, and the propleuron with some scattered white hairs; hairs on abdomen above granular, very dense, vellose, fur-like, mainly decumbent, those on tergite 1 submedially and on sides anteriorly more erect, snow white, as are also those on extreme sides of 2 and 3, and to a much lesser extent on extreme sides of rest of tergites; those across hind margin of tergite 1, on greater part of 2 discally, broadly on sides of 3-7 above more decumbent, directed backwards, dense, more creamy whitish, leaving a broad, but posteriorly-narrowing, central, black or dark streak, mainly covered with black, decumbent, granular, scale-like hairs, and with some scattered, pale ones, especially across hind margins of tergites; sides anteriorly

of tergites 3–5 also appearing dark, but covered with dark, fulvous brownish hairs; tergite 2 discally on each side also with a submedial, dark-haired patch; hairs on venter slightly less dense, whitish on sides of sternites, especially 1–4, the rest of the hairs appearing slightly fulvous in certain lights; hairs on legs mainly pale, long, dense and white on femora above, especially so along inner upper apical half of middle femora, and basally above on hind ones, and along hinder parts of front and middle tibiae; rest of hairs on legs shorter, gleaming more pale sericeous yellowish in certain lights; spines on hind femora below and spicules on hind tibiae more pale yellowish to pale fulvous yellowish, the rest of spicules on tibiae more whitish.

Head across eyes broader than thorax; eyes markedly large, convex; interocular space on vertex broader than interocular space on head below, as 30:20; vertex sunk in; antennae (Fig. 4, left), very close together, much shorter than thorax, joint 1 thickened, about $1\frac{1}{3}$ – $1\frac{2}{3}$ times length of 2, only a little longer than broad, joint 3 comparatively short, only a little longer than 1 and 2 combined, slightly thickened apically; club dilated, pyriform, somewhat laterally compressed, in side view broadest subapically much beyond middle, a little longer than rest of the joints combined, its apical sensory area, around the crater-like tubercle, sunk in, the tubercle itself rather long and prominent, quite as long as antennal joint 2, the inner margin of sensory area and inner apical part of club somewhat emarginate and depressed; buccal cavity small; proboscis much reduced, only about 0.32 mm long; palps not detectable.

Wings rather narrow, the membrane wrinkled, entirely hyaline, but with a scarcely perceptible milky whitish tint in certain lights; costal vein, subcostal and anterior vein of anal cell yellowish, the rest of veins yellowish brown; second submarginal cell with a very short appendix; first posterior cell slightly narrowed apically, opening on second vein (or very shortly stalked on costal margin); discoidal cell sharply acute apically and shortly stalked; alula fairly well developed, almost quadrate; halteres yellowish.

Legs comparatively short and hairy, as described under vestiture; hind femora slightly clavately thickened, armed below with a single row of 5 or 6 distinct spines from a little before middle to a little beyond middle, ceasing before broadest part of femora, those towards the apex the longest; front and middle femora subspindle-shaped, without any spines; front and middle tibiae curved, the spicules on anterior aspect longer, more hair-like on middle ones where the hairs on posterior part are also longer as they are on upper, posterior, apical part of middle femora; hind tibiae only slightly curved in apical part, its row of spicules (4) along lower outer aspect fairly long and stoutish, spine-like, its crown of apical spicules also longer and stouter than those on other tibiae; tarsi rather short, progressively longer from front tarsi to hind ones, the spicules below hind ones also much longer and stouter, the hind basitarsus a little longer than claw-joint; claws curved down apically; pulvilli well developed.

Hypopygium (cf. Fig. 4, middle and right) as described for the genus;

navicular sternite 9 with some stoutish setae on slight tubercles ventrally and anterolaterally; aedeagal apparatus comparatively short, rod-like, not forked apically.

This unique ♂ holotype is in the Stuttgart Museum.

Length of body: about 11 mm

Length of wing: about 7.5 mm

Distribution

South West Africa (H. Walter, 1/3/1953). (Without any reference to geographical region, but judging from the distribution of species of the related genus *Nothomydas*, probably also from some sandy desert part in Great Namaqualand.)

NAMIBIMYDAS n.gen.

Two specimens, a ♂ and a ♀ and both somewhat damaged, from the Namib Desert, submitted by Professor E. Lindner, represent a remarkable new genus which differs from all known genera of Mydaidae, not only in the peculiar genital structures of the ♂, but also in other morphological characters.

As the abdomen in both sexes has only 7 normal discernible tergites and sternites and the usual eighth tergite and sternite of other genera concealed, reduced or modified, this genus is also to be placed in the new tribe Halterorchini.

It is characterized as follows:

Body moderately large, elongate, asilid-like; abdomen stoutish, elongate, cylindrical in ♂, slightly dorso-ventrally depressed up to penultimate segment in ♀.

Head (cf. Fig. 5) markedly broad, much broader than thorax, broader than in most other genera; interocular space on vertex proportionally very broad, displacing the eyes laterally to a very marked extent, proportionally broader in ♂ than in ♀; interocular space on head below more or less equally broad in both sexes, the inner margins of eyes in ♂ thus more convergent below; eyes proportionally large for the broad head, larger in ♂ than in ♀, the facets along anterior inner aspect only slightly larger than the rest, slightly larger in ♂; median ocellus present; antennae of ♀ missing in the specimen, but in ♂ comparatively short and stout, joint 1 slightly thickened, joint 3 columnar, broadened apically, the club elongate pyriform, longer than joint 3 as in the other Halterorchini, its sensory area however more latero-apical; clypeus prominent; medial lower part of buccal cavity rather prominently jutting out lip-like; proboscis very characteristic, spear- or lance-shaped, very long and slender, like that of species of *Cephalocera*, the labella of ♂ narrower, lance-blade-shaped and that of ♀ more spear-blade-shaped (cf. Fig. 5, right and left); palps distinct, thickened apically.

Thorax with the integument, including that of the pleurae, dull; propleural part rather inflated, prominent, the central prosternal sulcus rather

deep and distinct throughout; mesopleuron with hairs on upper posterior part; metapleuron dull, with hairs.

Wings well developed, with strong veins; venation like that of most Sylleomydinae and especially that of the genus *Afroleptomydas*; alula well developed, lobe-like.

Abdomen with 7 normal, unmodified, unconcealed tergites and sternites in ♀ and also 7 tergites in ♂, but only 6 discernible sternites in ♂, sternite 7 being concealed and displaced forwards by the greatly developed sternite 9 (cf. Fig. 6); tergite 8 in ♂ concealed, only partly exposed on sides as a lobe at base of tergite 9 (cf. Fig. 6, left, VIII.T.), in ♀ as in other genera of the new tribe, modified to form the hood over the genital segments; sternite 8 in ♂ concealed or not developed and, in ♀, partially or half concealed above hind margin of sternite 7 and modified to form a ventral plate the hind margin, or

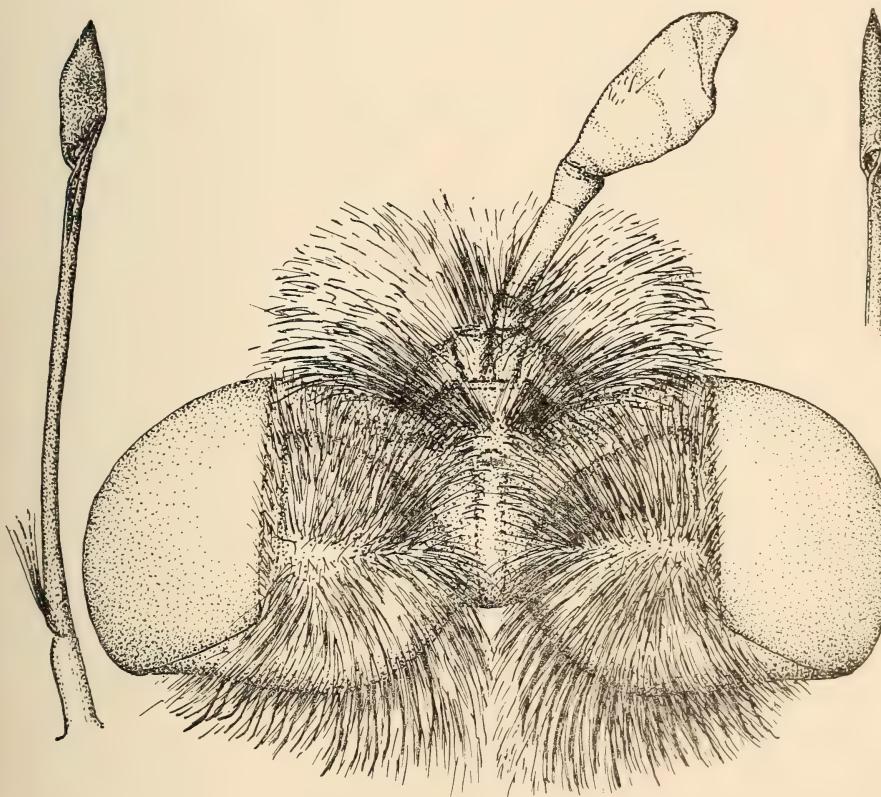


Fig. 5.

Dorsal view of head of ♂ of *Namibomydas gaerdesi* n.gen. et n.sp.

Left: Proboscis of ♀ of same species.

Top right: Apical part of proboscis of ♂.

All drawn to the same scale.

hind part, of which is indented or emarginated V- or U-shaped (cf. Fig. 7, right); tergite 2, as in other genera, broadly transversely depressed across base; bullae on segment 2 minute in ♀.

Legs (much damaged in the specimens, some of the legs and tarsi missing) in both sexes however fairly long; trochanters (cf. Fig. 7, left) of front and middle legs distinctly produced more lobe-like in outer basal part than in most genera, and slightly smaller in ♀ than in ♂; hind femora slightly thicker than the other femora, armed with a double row of spines below; front and middle femora also with some spines below; tibiae with long and conspicuous spicules, those in the apical crown (spurs) markedly and conspicuously long as are also those on tarsi (probably an adaptation to the sandy and dune-sand environment); claws and pulvilli very strongly developed in ♂, less so in ♀, in which sex the pulvilli are also relatively shorter.

Vestiture well developed, with markedly dense, long, bushy, and finely granulate hairs on head (cf. Fig. 5), sides of mesonotum, metanotum, hind margin of mesopleuron, on pteropleuron, metapleuron, base of abdomen, to a lesser extent on rest of abdomen, hypopygium of ♂, on coxae, and femora; hairs on disc of mesonotum slightly shorter; those on abdomen above in ♀ shorter and less dense beyond tergite 2; tomentum on head and body well developed in both sexes.

Hypopygium of ♂ (cf. Fig. 6) remarkable, large; tergite 9 deeply indented U-like, divided dorsally into a lateral part or lobe on each side, with the well-developed anal lobes in between, and each lateral lobe depressed apically, the depression extending ventrally as an infolded sheet which is connected with the dorsal process or prong on each side of sternite 9; the latter enormously developed, *Argonauta*-shell-shaped, laterally compressed, ventro-laterally grooved on each side, keeled below, the entire structure displacing sternite 7 far forwards under sternite 6 so that only 6 abdominal sternites are discernible; sternite 9 itself centrally sulcate in posterior (or apical) vertical part, and connected on each side with a broad, flattened, dorsally slightly hollowed, apically slightly outwardly- and downwardly-directed, bluntly rounded process or prong which curves apicalwards from about middle of the sternite and each of which, on dorsal apical part of the sternite, is connected to the latter by more transparent chitin; tergite 8 almost entirely concealed, only an exposed lobe-like lateral part discernible, a projecting appendage or lobe (cf. Fig. 6, AP.) on each side of sternite 9 may represent an appendage or process on each side of the concealed sternite 8 as in some species of *Namadytes*; aedeagal part entirely hidden, discernible from a posterior view as a forwardly-bent hook, from the base of which there extend apicalwards 2 filament- or strand-like structures (cf. Fig. 6, right top); hairs on hypopygium dense and long on extreme sides of tergite 9, below anal lobes, on processes of sternite 9, posteriorly on latter, and on each side of concealed tergite 8 (projecting from under tergite 7), with the hairs posteriorly on hypopygium curved inwards and downwards hiding posterior vertical part of sternite 9.

Genital segments of ♀ (cf. Fig. 7, right) as in other genera of the Syllegomydinae, but with tergite 8 in form of a hood over the terminal, central, carinate ridge and acanthophorites; sternite 8 however half hidden under sternite 7, its hind margin indented, V-shaped, and with the sides of the V swollen and rugose; central carinate ridge of sternite 9 well developed, arched; acanthophorites each with comparatively short, broad, shoe-horn-shaped, blunt spines, hollowed dorsally.

The type-species of this new genus is *Namibimydas gaerdesi* n.sp. which I have great pleasure in naming for Herr F. Gaerdes of Okahandja who collected it, who is well known as a keen and enthusiastic collector of insects in South West Africa and who, from his extensive private collection, has contributed much interesting insect material from that part of southern Africa to museums in South Africa and in Germany.

Namibimydas gaerdesi n.sp.

This interesting species is characterized as follows:

Body-colour mainly black, with the lower apical half of antennal club appearing obscurely reddish, the sensory area more yellowish brown; proboscis black, its extreme base, lower part of buccal cavity, and the palps yellowish; thorax with the anterior spiracular area behind humeral tubercles, pleural part just below spiracle, the fossa between propleural and prosternal parts, sutural part above between humeral tubercles and mesonotum, notopleural part, outer part of postalar calli, middle part of hind margin of scutellum, scleritic area around wing-bases (partly encroaching upon or embracing also mesopleural, pteropleural, and metapleural parts), sutural parts on rest of pleurae and, in ♀, also 2 central streaks on metanotum reddish yellow to pale yellowish brown; these coloured parts, in ♀, tending to be more extensive, affecting even greater part of pleurae which tends to be more reddish brown; disc of mesonotum in ♀ also tending to show an obscure central and an obscure lateral reddish brown streak on each side; abdomen above mainly dark or black, in ♀ tending to be more dark brownish, becoming paler, more yellowish brown, posteriorly, the sides in both sexes also more yellowish or pale brownish, more so in ♀; hind margins of tergites yellowish white on sides, more broadly so across posterior lateral angles; bullae black in both sexes, small in ♀, very widely separated, surrounded by pale yellowish brown; venter yellowish brown, the hind margins of sternites 1-4 in ♀ and 1-6 in ♂ broadly yellowish white; genital structures of ♀ pale yellowish brown; extreme sides of tergite 9 and narrow hind margin of its lateral part in ♂, as well as greater part of hypopygial structures also pale yellowish brown, excepting posterior, shining-black, lateral and vertical parts of sternite 9; a small spot near posterior apical angle of lateral part of tergite 9 in ♂ yellowish; legs mainly yellowish in both sexes, the coxae in ♂, excepting the broadish pale yellowish brown hinder part, dark or blackish, the front and middle femora on upper outer aspect to beyond middle, and inner face of hind femora darkened, more brownish, especially in

♂, and apical parts of tarsal joints also darkened, and apical parts of claws black.

Integument of head and body mainly dull, covered with greyish white tomentum; sides of tergites, especially in ♀, more subshining, transversely rugulose and punctured, tergites 6 and 7 more extensively transversely rugulose; transverse basal depression across tergite 2 shining; hood-like tergite 8 in ♀ more shining, more coarsely punctate-rugose, as are also the semi-inflated hinder parts of sternite 8 in ♀; modified tergite 9 in ♀ coarsely punctured; venter shining, transversely grooved or wrinkled laterally, more so in ♀; sternite 9 and its dorsal processes in ♂ shining, its lower keel-like part, from just before middle, longitudinally striate; legs shining, the femora finely transversely striate.

Vestiture on head, body and legs mainly white, that on head long and dense, that on frons in front, antennal joints 1 and 2, clypeus, and genae more straw-coloured, more so in ♀; postvertical spines distinct, slender, bristle-like, yellowish; hairs on occipital part laterally behind eyes white, shorter than rest of cephalic hairs; palps with a tuft of long white hairs; base of proboscis with a pencil of long white hairs; hairs on mesonotum slightly less dense and shorter than rest of hair on thorax, but denser and slightly longer in ♂ than in ♀, with a faint straw-coloured tint in certain lights, inclining to be arranged in 5 streaks, corresponding with more or less 5 streaks of whitish tomentum, of which the

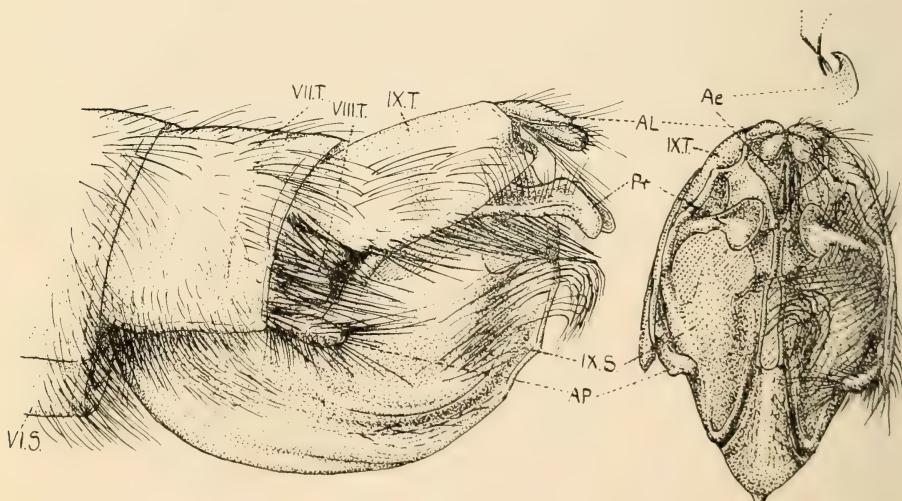


Fig. 6.

Side and posterior views of hypopygium of ♂ *Namibimydas gaerdesi* n.gen. et n.sp. The posterior view is drawn with the vestiture only on one side.

(Ae = aedeagal structure as far as this can be made out in specimen, the top right is a side view with all the parts not discernible; AL = anal lobes; AP = appendage of concealed segment 8; IX.S. = Argonauta-shell-shaped sternite 9; IX.T. = tergite 9; Pr = processes of sternite 9; VI.S. = sternite 6; VII.T. = tergite 7; VIII.T. = tergite 8.)

central one is narrow, the 3 middle hair-streaks, separated by 2 almost bare streaks, more evident in ♂; tuft on humeral angles, hairs along notopleural part, on postalar calli, and in front of base of scutellum dense, long, and snow white; those on metanotum also long, snow white; pleurae mainly bare, tomented, but hairs on upper hinder part of mesopleuron, on pteropleuron, and metapleural part in dense snow white tufts; those on sternal parts also long and snow white; hairs on abdomen long, snow white, long and dense basally on sides of tergites 1 and 2 and, in ♂, fairly long and dense on rest of tergites, below anal lobes, along upper lateral part of processes of sternite 9, sides below processes, posterior part of sternite 9, and on sides of concealed tergite 8; hairs on abdomen in ♀ shorter and sparser beyond tergite 2, slightly denser and directed forwards on last 2 tergites; hairs on venter much longer and slightly denser in ♂, shorter and sparser in ♀; hairs on legs also mainly white, long and dense on femora above, much more so in ♂, those in tibiae shorter, but longer in ♂ than in ♀.

Head (cf. Fig. 5) distinctly much broader than thorax, broader in ♂ than in ♀, quite 5.75 mm in ♂ and 4.96 mm in ♀; interocular space on vertex markedly broad, proportionally broader in ♂ (± 3 mm) than in ♀ (± 2.2 mm); vertex on the whole not much sunk in, but central ocellar ridge ends on vertex in a fairly deep sulcus, the boss-like part on each side very prominent; antennae (missing in the ♀ specimen) nearly as long as width of interocular space on vertex in ♂, with joint 1 thickened, quite $1\frac{1}{2}$ times length of 2, joint 3 stout, columnar, longer than combined length of 1 and 2, shorter than club, its apical part broadened; club elongate pyriform as shown in Figure 5; clypeus convex, somewhat shining, its apex slightly notched; buccal cavity fairly deep, its lateral margins sharply carinate, the middle part on lower margin projecting prominently ledge-like, more broadly so in ♂; proboscis slender, markedly elongate, javelin-shaped in ♂ (Fig. 5, right), spear-shaped in ♀ (Fig. 5, left), about 4.64–4.68 mm long, the labella narrow in ♂ and lance-blade-shaped, slightly broader and spear-blade-shaped and more sharply pointed in ♀; palps in ♂ more roundly inflated apically, in ♀ more subspindle-shaped.

Wings reaching tip of abdomen, clear, hyaline, with a faint milky whitish tint in certain lights; membrane much wrinkled; venation similar to that of the genus *Afroleptomydas*; veins rather stoutish, yellowish; first posterior cell slightly narrowed apically, either opening on second vein in ♀ (thus very shortly stalked apically on costal margin) or partly opening on second vein and partly on costal margin in ♂ (thus apically narrowly sessile on costal margin); second submarginal cell with an appendix basally; discoidal cell acute apically, meeting third posterior cell at a point; axillary lobe broad; alula well developed, lobe-like; halteres whitish.

Legs (much damaged in ♀ specimen and some tarsi missing in ♂ specimen) moderately long, hairy, the hairs on front and middle femora above and, especially, along inner upper aspect of hind femora markedly long and dense,

more so in ♂, and the hairs on tibiae also longer in ♂ than in ♀; front femora with 3 yellowish spines below in ♂ and 2 pallid ones in ♀; middle femora more slender, unarmed below; hind femora slightly thickened, with a double row of reddish yellow spines below (4–5 in inner row and 6–7 in outer one) on slight tubercles, the outer row ending in 3 or 4 more closely-spaced and shorter ones along outer margin of the apical femoro-tibial articulating cavity; tibiae with more or less a double row of markedly long yellowish red to reddish spicules along outer lower part, ending in a crown of conspicuously long apical ones; tarsi also with markedly long reddish spicules on joints below, the basal joint of hind tarsi longer than claw-joint; claws strongly developed, more so in ♂; pulvilli in ♂ strongly developed, broad, about reaching curved apices of claws, in ♀ distinctly less strongly developed, narrower, shorter than in ♂, not reaching apices of claws.

Hypopygium of ♂ (cf. Fig. 6) as described for the genus.

Genital segments of ♀ (cf. Fig. 7, right) as described for the genus; acanthophorites each with about 8 spines of which the first basal spine is slender and more rod-like and the other 7 (only 2 on each side in the specimen are still present, the slightly hollow bases of attachment of the lost ones however indicate the original total) are broad, shortish, bluntly rounded, cuneiform or shoe-horn-shaped, and hollowed above; hinder V-shaped emarginated part of semi-concealed sternite 8 thickened or inflated, rugulose, and sparsely punctured

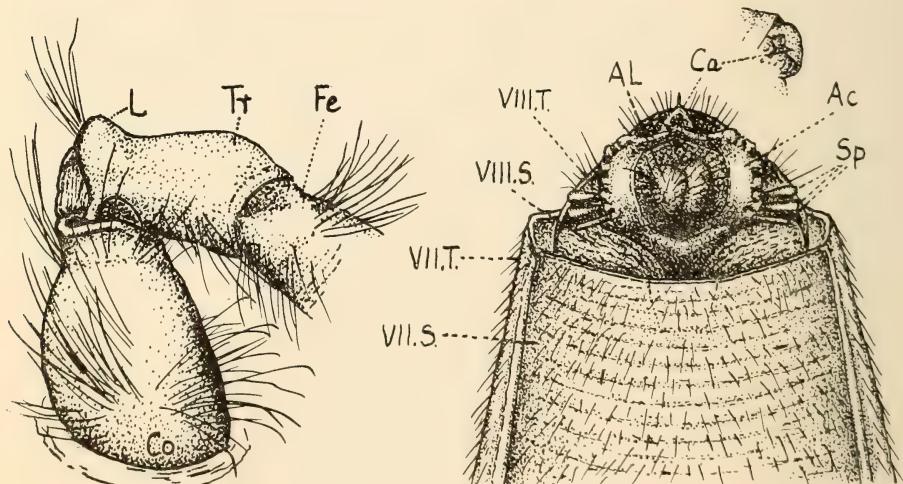


Fig. 7.

Left: Ventral view of coxa, trochanter and part of femur of middle right leg of ♂ *Namibimydas gaerdesi* n.gen. et n.sp.

Right: Posteroventral view of genital segments of ♀ *Namibimydas gaerdesi* n.gen. et n.sp.
(Ac = acanthophorite; AL = anal lobes; Ca = central carina (ventral and side views) of last ♀ genital segment; Co = coxa; Fe = femur; L = flattened lobe-like extension of trochanter; Sp = spines of acanthophorite; Tr = trochanter; VII.S. = sternite 7; VII.T. = tergite 7; VIII.S. = sternite 8; VIII.T. = tergite 8.)

on each side, each puncture lodging a short hair.

From the 1 ♂ holotype and 1 ♀ allotype in the Stuttgart Museum.

Length of body: about 21–24.5 mm

Length of wing: about 16–19 mm

Distribution

South West Africa: Namib Desert: Walvis Bay (F. Gaerdes, 24/1/1939 (♀) and 20/1/1940 (♂)).

The ecology and biology of this interesting genus are unknown, but the various morphological features of the type-species, such as its excessive hairiness, the hairy legs with the markedly long tibial and tarsal spicules, and the comparatively broad, shortish, shoe-horn-shaped spines on the acanthophorites of the female, indicate adaptive responses to a hot and sandy environment.

Subfamily Mydinae

PARECTYPHUS n.gen.

One of the specimens of Mydaidae from South West Africa, kindly submitted to me by Professor E. Lindner of the Stuttgart Museum, belongs to a new genus of Mydinae and very near to the genus *Ectyphus* Gerst. Up to now the genus *Ectyphus* appears to be restricted to the southern and eastern Cape, Natal, Transvaal, and possibly East Africa. It is an eastern genus of which the species occur in semi-wooded and forested parts. This new genus may be considered as representing *Ectyphus* in the Namib Desert of South West Africa. Though not stated on the locality label this mydaid, like *Ectyphus*, probably also inhabits a wooded environment, even in the treeless Namib, namely that found along the banks of the Kuiseb River.

It differs from the genus *Ectyphus* in the following respects:

Body comparatively and markedly broader, the head and thorax proportionally much broader, the abdomen in the male sex less cylindrical, more flattened dorso-ventrally. Its general appearance suggests that of a cricket.

Integument very similar to that of *Ectyphus*, but the disc of the mesonotum more finely leathery or rugulose, not so coarsely rugulose and also less dull; that of abdomen above smoother, though also setiferously punctured and with an intramarginal streak of coarse puncturation on sides of abdomen.

Vestiture with the hairs on head in front, thorax above, and on pleurae in the ♂ on the whole distinctly longer and denser than in even the most hairy species of *Ectyphus* known.

Head markedly broad, only slightly broader than across broadest part of the broad thorax, the latter proportionally less broad in *Ectyphus* making the head appear much broader; interocular space on vertex proportionally much broader, much broader than distance from base of ocellar ridge on vertex to base of clypeus which distance, in *Ectyphus*, is equal, subequal to, or even a little shorter than, interocular space; interocular space on head below pro-

portionally also broader; clypeus flat-nose-shaped as in *Ectyphus*; proboscis also reduced and short, resembling that of *Ectyphus*; antennae (cf. Fig. 8, left) proportionally shorter, much shorter than mesonotum, the clubs more pyriform, not so elongate-pyriform or spindle-shaped as in *Ectyphus*, the apical sensory area and apical prominence less produced.

Wings with 3 submarginal cells, not 2 only as in *Ectyphus*, the normal second has the basal appendix (which is present in all known species of *Ectyphus*) joined to the posterior border vein of the marginal cell thus dividing the first submarginal cell into 2 cells and thus forming the 3 submarginal cells, of which the third is an enclosed cell; first posterior cell broadly opening on costal margin apically.

Legs as in *Ectyphus*, but hind trochanters without any spines or processes; hind femora also markedly thickened, but more clavately so, their apices more narrowed, armed below in broadest subapical part and also sublaterally in apical part with stoutish spines on tubercles; front and middle femora unarmed below; front and middle tibiae armed with longer, stouter, spine-like spicules than in *Ectyphus*, and apically with much longer apical spicules; hind tibiae centrally carinate below as in *Ectyphus*, the carina also ending apically in a blunt process, but the spicules on hind tibiae more developed and with 2 long apical spicules on outer side of apical tibial process; tarsi with much stiffer short hairs and longer spicules; claws more strongly developed and longer, and the pulvilli well developed.

Abdomen markedly broad and flattened dorso-ventrally, even in ♂, more so than in some ♂♂ of *Ectyphus*, otherwise as in latter genus; tergite 8 concealed, but sternite 8 exposed as a scoop-like sclerite below and taking the place of the normal sternite 9 of most Mydaidae; lateral lobes of tergite 9, unlike the

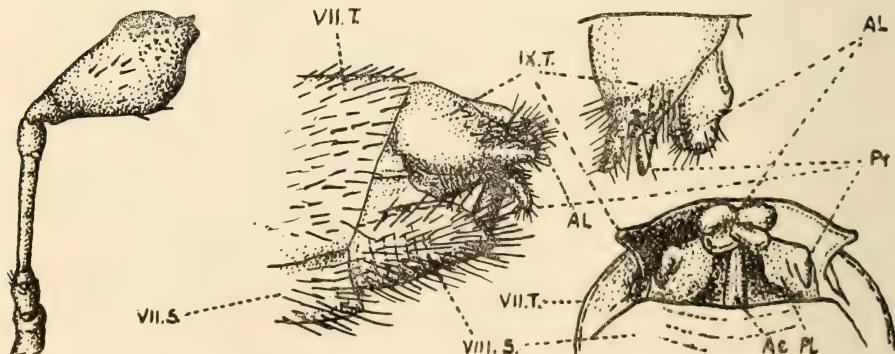


Fig. 8.

Right antenna of ♂ *Parectyphus namibiensis* n.gen. et n.sp.

Middle: Left view of posterior end of abdomen and hypopygium of same species.
Right top: Dorsal view of left lobe of tergite 9 and anal lobes of same species.

Right bottom: Posterior view of hypopygium.

(Ae = aedeagus; AL = anal lobes; IX.T. = lobes of tergite 9; PL = plate bearing process (Pr.) of hidden sternite 9; VII.S. = sternite 7; VII.T. = tergite 7; VIII.S. = sternite 8.)

much rounded or subangular, half-concealed, lateral lobes of *Ectyphus*, well developed, broad, prominent, and produced spinelike posteriorly on each side (cf. Fig. 8); sternite 9 not discernible, probably modified and in part represented by the transverse, shield-like plate (cf. Fig. 8, Pl.).

Hypopygium (cf. Fig. 8, middle and right) of ♂ differs from that of ♂♂ of *Ectyphus* in having the process or prong on each side of the concealed sternite 9 not curved inwards or tongs-like, but produced posteriorly on each side as a downwardly-bent hook, without any projecting appendage below, the base inside of each hook, from a posterior view, arising from a transverse plate (cf. Fig. 8, right below) which in part may represent sternite 9; aedeagal apparatus columnar and, as far as can be seen in the unique ♂ specimen, in form of a downwardly-directed, slightly laterally-compressed tube (cf. Fig. 8 Ae), without any cowl-like or inverted cup-like cap as in *Ectyphus*.

This new genus of South African Mydinae, with 3 submarginal cells in the wings, alters my definition of the subfamily (Hesse 1969: 9, 19, 364, 365) in which it was stated that the wings have only 2 submarginal cells and that the second opens either on the costal margin or on the second vein, and that a posterior cross vein is present or not.

In this new genus there are 3 submarginal cells, the second opens, as in *Ectyphus*, on the second vein, and a posterior cross vein is also present.

To accommodate this new genus and to correct statements as to the characters of the known African genera of the Mydinae the following revised part of the key to the subfamilies and genera of African Mydaidae is proposed.

- 1(a) Wings with 2 or 3 submarginal cells, the third, if present, formed by bisection of the first by the extension of the basal appendix of the second 2 (Subfamily *Mydinae* Beq.)
- (b) Wings with 3 submarginal cells of which the second is in form of an enclosed and apically-stalked cell between the first and third Subfamily *Diochlistinae* Beq. (Non-African)
- 2(a) Second submarginal cell opening on second vein and with an appendix, or extended and bisecting appendix (vein) at base; hind border of wings with a distinct cross vein; clypeus broad, convex, flat-nose-shaped; antennal joint 3 much longer than 1 and 2 combined; hind femora markedly thickened, incrassate, usually with more than 2, usually 4, rows of spines below; hind tibiae compressed, medially carinate below, the carina ending in an apical process or spine in ♂♂ 3
- (b) Second submarginal cell opening directly on costal margin, usually without a basal appendix; hind border of wings without a cross vein; clypeus not flat-nose-shaped; antennal joint 3 short, or very short, shorter than 1 and 2 combined; hind femora usually less markedly incrassate, with fewer, or only 2, rows of spines below; hind tibiae usually without a carina below 4
- 3(a) Wings with only 2 submarginal cells, the base of second with an appendix; head and body narrower, the abdomen in ♂♂ more cylindrical or subcylindrical; hind trochanters with 1 or 2 spines below; spicules on tibiae shorter, less developed; lateral lobes of tergite 9 in ♂♂ less produced, more rounded, lobe-like, or only subangular; processes of sternite 9 in ♂♂ curved more inwards, blunter, with a distinct palp-like appendage below; aedeagal apparatus stoutish, conical, ending apically in a cowl-like cap; terminal part of oviscapte in ♀ usually withdrawn into segment 7 *Ectyphus* Gerst.
- (b) Wings with 3 submarginal cells of which the third (enclosed) is formed by the bisection of first by the basal appendix of the second joining anterior vein of normal first sub-marginal; head and body markedly broad, the abdomen in ♂ broader, more dorso-ventrally flattened; hind trochanters without spines; spicules of tibiae more developed, longer; lateral lobes of tergite 9 in ♂ well developed, prominent, produced spine-like; processes of sternite 9

directed posteriorly, bent down hook-like apically, without any projecting appendage; aedeagus columnar, slightly laterally compressed, without a cowl-like cap

δ *Parectyphus* n. gen.

- 4(a) Antennae shorter, the clubs normally dilated or inflated, not constricted at middle, not appearing deformed *Rhopalia* Macq. (from Egypt)
 (b) Antennae longer, the clubs enlarged, constricted at middle, their basal part broadened or extending lobe-like laterally, or with lobe-like extensions, appearing deformed or malformed *Perissocerus* Gerst. (North African)

The type-species of the new genus *Parectyphus* is *Parectyphus namibiensis* n.sp.

***Parectyphus namibiensis* n.sp.**

The δ holotype of the type-species is characterized as follows:

Body mainly black; antennae blackish brown, the clubs more yellowish brown, becoming paler in apical third, but apical tubercles blackish; buccal cavity and proboscis yellowish brown; anterior thoracic or shoulder spiracles, sides of mesonotum above wing-bases, and postalar calli more reddish brown and so is the area below wing-bases; hind margins of sternites 2 and 3 slightly yellowish brown; hypopygial parts yellowish brown; legs with the femora dark reddish black, the knees yellowish brown, the front and middle tibiae and tarsi also reddish black, the hind tibiae more dark reddish brown, their tarsi also reddish black; claws yellowish brown, black-tipped.

Integument of central part of frons and clypeus smooth and shining; that of mesonotum dull, finely rugulose; scutellum dull, finely rugulose, its hind border, posterior to a slight transverse depression, finely longitudinally rugulose; metanotum dull, finely rugulose, but with a few transverse rugae, especially on sides; pleurae mainly shining, but posterior border of mesopleuron, parts of sterno- and hypopleurae, opposite middle coxae (pore region), upper part of pteropleuron, and to a certain extent metapleural part, wrinkled; inflated lateral part of tergite 1 longitudinally striated; abdomen above transversely depressed just behind base of tergite 2, rest mainly smooth, but not too densely setiferously punctured, denser so posteriorly, but discal part of lateral lobes of tergite 9 mainly smooth, though showing fine, shallow, transverse striation in certain lights; venter smooth, shining, with sparse, setiferous puncturation in basal half, becoming denser posteriorly, sternite 7 with some transverse rugae posteriorly and 8 more coarsely transversely rugose and setiferously punctured; legs mainly shining, the femora transversely striate, the hind ones more coarsely so basally.

Vestiture with very dense and long, silvery-gleaming, snow white hairs on head, those on sides of frons in front and on clypeus directed downwards awning-like, also with whitish tomentum on sides of frons, face, and occiput; hairs on vertex and less dense and shorter ones on head below also silvery-gleaming snow white; vertex without any distinguishable, post-vertical spines or setae; first antennal joint bare, the second with a crown of a few hairs; hairs on mesonotum arranged in punctures also entirely silvery-gleaming snow white, but much shorter than on head, denser and longer only along noto-

pleural part and in front of scutellum, discally absent from more or less 5 longitudinal streaks, the middle 3 more evident, hairs also absent from postalar callar region and along middle of scutellum; metanotum bare; hairs across hind margin of mesopleuron, on pteropleuron, sides of metasternum, outer sides of middle and hind coxae, tergite 1, especially sides, and on anal lobes, long and silvery-gleaming snow white; those on rest of abdomen above not very dense and in setiferous punctures, those on lateral lobes of tergite 9, sparse ones on venter, dense, stouter and longer ones on sternite 8, those on prosternal part, front coxae, on discal parts of middle and hind coxae, and on legs, including the spines and spicules, dark or black.

Head with joint 1 of antennae (cf. Fig. 8, left) only slightly thickened, only about 1.4 times length of 2, joint 3 only a little more than twice length of 1 and 2 combined, slightly thickened in the joint-like apical part; club slightly longer than joint 3 (as 6:5), dilated pyriform, its base slightly constricted neck-like, broadest at about apical third, with short, scattered, black hairs, arranged more or less transversely and more on outer side from about basal third to apical third, the apical part of club subtruncate on inner aspect and with the tubercular prominence on outer apical aspect rounded, crater-like and with a short central style; clypeus narrowly separated from inner margins of eyes; lower middle part of buccal cavity rather prominent, lip-like; proboscis shorter than antennal joint 3, its labellar part subequal in length to rest or basal stem, covered with fine, short spinules; palps minute.

Wings projecting a little beyond apex of abdomen, hyaline, with a very faint milky white tint, the membrane much wrinkled; veins yellowish brown, more yellowish in basal part, the costal vein appearing dark due to the short black setae along its course to about level of first posterior cell; venation as described for the genus; alula broad, lobe-like; first posterior cell broadly opening on costal margin; halteres dark, the knobs black.

Legs with the hind femora clavately thickened, slightly curved basally, broadest part at about apical third and, apart from the rather stiff setae-like and short hairs, are armed below with 2 rows of stoutish spines on slight tubercles, mainly concentrated in apical broadest part, the outer row beginning as isolated spines from near base, the inner row from about or beyond middle, in addition there are an outer lateral row of 3 or 4 spines in apical part, a few irregularly-situated ones on inner lateral aspect, and a few dorsal ones in apical part or half; front and middle femora covered above with rather long stiff hairs and longer, setae-like hairs, the middle femora more curved than front ones; front and middle tibiae with fairly dense, stiff, black hairs and long, spine-like spicules, the apical ones below markedly long; hind tibiae with much finer, shorter, and sparser hairs, denser towards apex, and with fewer, shorter, and finer spicules, the apical ones on outer side of apical tibial process longest; apical process on hind tibiae below only moderately long and stout; tarsi with dense, stiff, black hairs and long spicules, the front and middle tarsi shorter than their tibiae and also shorter than hind tarsi, the latter also shorter

than their tibiae and with the basal joint longer than the claw-joint (minus claws); hind claws longer than the others, and all claws sharply bent down apically.

Hypopygium (cf. Fig. 8, right) as figured and described for the genus.

The unique ♂ holotype is in the Stuttgart Museum.

Length of body: about 15 mm

Length of wing: about 12.5 mm (the tips of both wings broken off in the specimen).

Distribution

South West Africa: Gobabeb (23.3 S. 15. O E. 408 m.). This locality name is not shown on maps, but is about 112 km south-east of Walvis Bay on the Kuiseb River in the Namib Desert and, at present, is the site of the Namib Desert Research Station.

SUMMARY

In this paper, an addendum to my 'Revision of the Mydidae (Diptera) of southern Africa', three new genera and sixteen new species from the Namib Desert and other parts of South West Africa are described. The genus *Namamydas* Hesse, described in 1969, is sunk as a synonym of *Namadytes* Hesse and a key is given to separate the known species of the latter. A new tribe Halterorchini is erected to accommodate the anomalous genera *Halterorchis* Bezzii, *Nothomydas* Hesse, and the two new genera *Mimadelphus* and *Namibomydas*. A short descriptive key for the separation of these genera is appended. A revised key to the subfamily Mydinae, to include the new genus *Parectyphus*, is also given. In 8 text-figures certain genital structures which help to distinguish some of the new species and the more important structures of the new genera are illustrated. A short list of the more important bibliographical references is added.

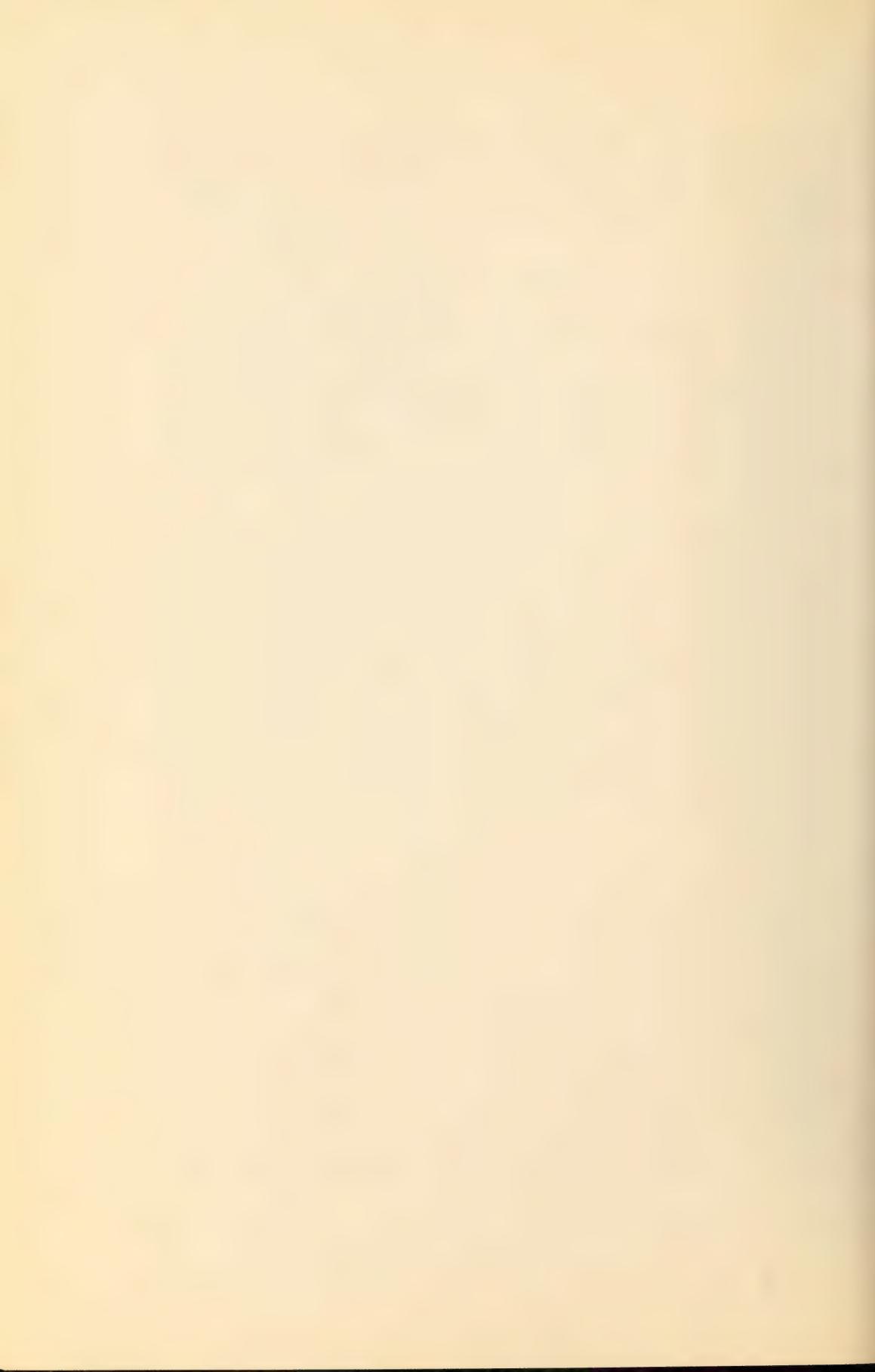
ACKNOWLEDGEMENTS

In the preparation of this paper my thanks are due to the following persons for kindly submitting valuable specimens for identification and description, or for collecting Mydidae in South West Africa and generously donating the material to the South African Museum: Professor E. Lindner of the Staatliches Museum für Naturkunde in Stuttgart who very kindly submitted the representatives of the new genera and species housed in the said museum; Herr F. Gaerdes of Okahandja in South West Africa who collected some of these specimens; Dr H. D. Brown of the Department of Agricultural Technical Services in Pretoria who, in his pursuit of Orthoptera in South West Africa, found some time to collect most of the new species of *Afroleptomydas* and to present them to the South African Museum; Dr J. G. Rozen and Mr E. Martinez of the American Museum of Natural History who collected one of the

new species in the southern part of South West Africa and kindly presented it to the South African Museum; and to Mr F. Gess of the Albany Museum who, while still on the staff of the South African Museum, collected two new species at Port Nolloth and on the South West African bank of the Orange River respectively.

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FISCHER, P.-H. 1948. Données sur la résistance et de la vitalité des mollusques. *J. Conch.*, Paris **88**: 100–140.

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THIELE, J. 1910. Mollusca: B. Polyplacophora, Gastropoda marina, Bivalvia. In SCHULTZE, L. *Zoologische und anthropologische Ergebnisse einer Forschungsreise im westlichen und zentralen Süd-Afrika*. **4**: 269–270. Jena: Fischer. *Denkschr. med.-naturw. Ges. Jena* **16**: 269–270.

ZOOLOGICAL NOMENCLATURE

To be governed by the rulings of the latest *International code of zoological nomenclature* issued by the International Trust for Zoological Nomenclature (particularly articles 22 and 51). The Harvard system of reference to be used in the synonymy lists, with the full references incorporated in the list at the end of the article, and not given in contracted form in the synonymy list.

Example

Scalaria coronata Lamarck, 1816: pl. 451, figs 5 *a*, *b*; Liste: 11. Turton, 1932: 80.





A. J. Hesse

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FROM THE NAMIB DESERT AND
SOUTH-WESTERN AFRICA

VOLUME 60 PART 4

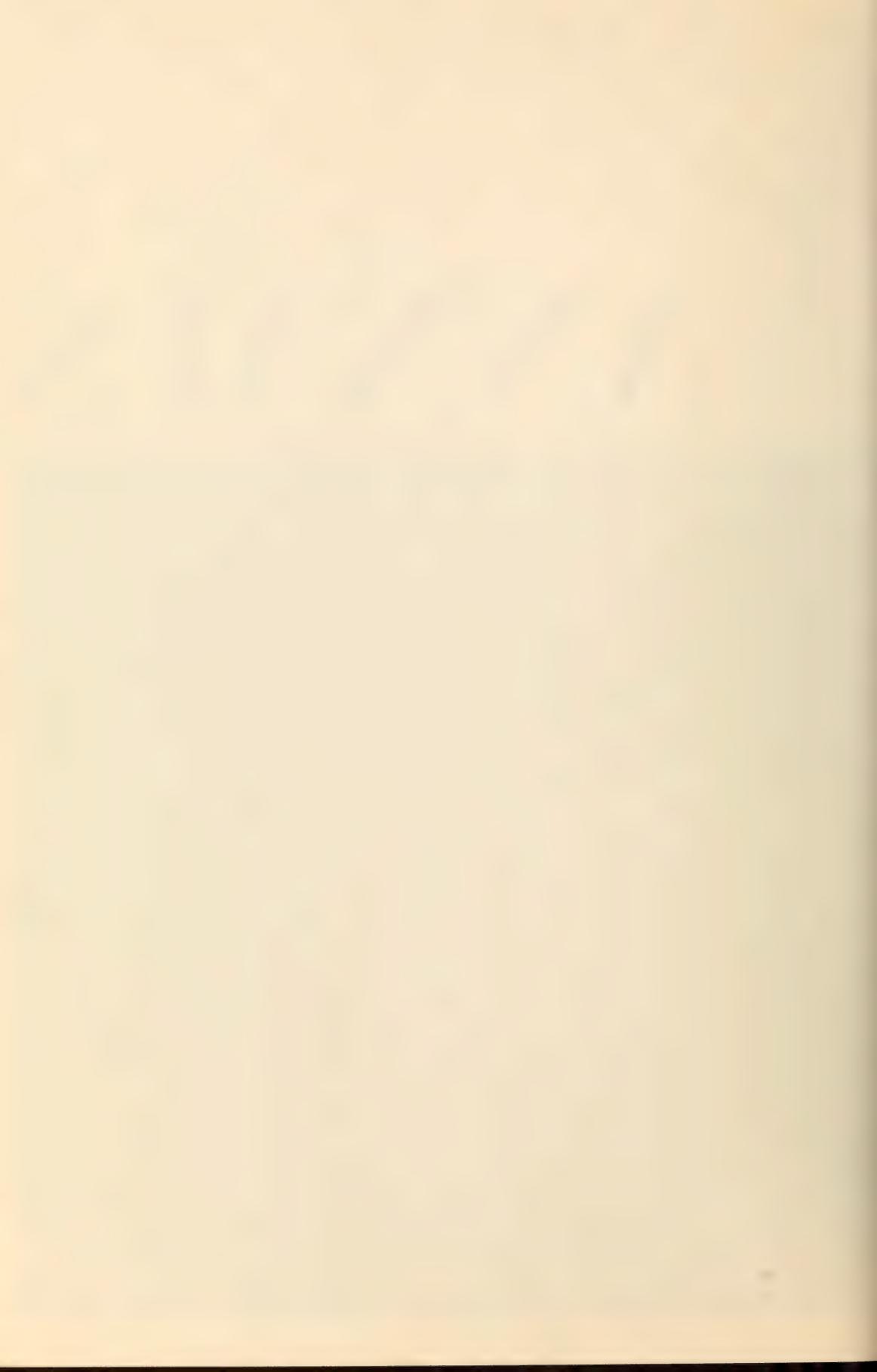
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ANNALS OF THE SOUTH AFRICAN MUSEUM

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Volume **60** Band
November **1972** November
Part **4** Deel



PLIOCENE MARINE INVERTEBRATES FROM
LANGEBAANWEG, CAPE PROVINCE

By
BRIAN KENSLEY

Cape Town Kaapstad

The ANNALS OF THE SOUTH AFRICAN MUSEUM

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1, 2(1, 3, 5, 7-8), 3(1-2, 5, t.-p.i.), 5(1-2, 5, 7-9),
6(1, t.-p.i.), 7(1-3), 8, 9(1-2), 10(1),
11(1-2, 5, 7, t.-p.i.), 24(2), 27, 31(1-3), 33

Price of this part/Prys van hierdie deel
R2,00

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1972

ISBN 0 949940 18 6

Printed in South Africa by
The Rustica Press, Pty., Ltd,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

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By

BRIAN KENSLEY

South African Museum, Cape Town

(With 9 figures)

[MS. accepted 12 June 1972]

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INTRODUCTION

The deposits which are being commercially exploited for their phosphate content at Langebaanweg, 105 kilometres north-north-west of Cape Town, are of palaeontological significance mainly because of the unique assemblage of Pliocene mammals which they have yielded (Hendey 1970a). Non-mammalian vertebrate remains are not uncommon (e.g. Simpson 1971), but until recently invertebrate fossils were rare, although the occurrence of marine molluscs in the deposits had been noted (Hendey 1970a). During 1971 two assemblages of marine invertebrates were recovered from 'E' quarry, and it is this material which is here described.

The present paper is in the nature of an inconclusive report, mainly on the molluscs. In some cases specific identification is given with almost no uncertainty. In several cases, however, the generic and even the familial position of the specimens is in doubt. Where these have been speculated upon, it is quite possible that with further and more complete material becoming available, the taxonomic position of the specimens will be altered. In some cases, certainty may never be reached, as structures such as radulae and operculae, which are essential for an accurate identification, are not preserved. Whether further material will in fact become available is doubtful, considering the difficulties involved in obtaining fossiliferous phosphatic matrix, and in removing the fossils from this extremely resistant matrix.

The first series of specimens (South African Museum L14187) were recovered from an exposure near the south-western corner of 'E' quarry. These

fossils, which are very well preserved and show almost no sign of being beach-worn, were embedded in a cemented, fine-grained brown phosphate rock that was adhering to an older, water-worn and heavily indurated phosphate rock. A few isolated shark's teeth (*Odontaspis* sp.) occurred in association with the invertebrates.

The second assemblage (S.A.M. L14259) was recovered from a trench in the eastern part of the quarry (BDT 2/1971), and these specimens, of which only internal casts and external impressions were preserved, came from a consolidated non-phosphatic light-coloured silt that was also adhering to boulders of heavily indurated phosphate rock.

At both localities the indurated phosphate rock occurs as rounded water-worn boulders, cobbles, and pebbles, and these together with the deposit containing the invertebrate fossils, occur in a loose and non-phosphatic sand and silt. The latter deposit also contains the remains of marine vertebrates such as sharks, teleosts, and whales, and grades upwards into a non-marine deposit from which most of the 'E' quarry terrestrial fossils are recovered.

SYSTEMATICS

CEMENTED PHOSPHATIC MATRIX (L14187)

Phylum **MOLLUSCA**

Class **GASTROPODA**

Order **ASPIDOBANCHIA**

Family **Patellidae**

Cellana capensis (Gmelin)

Cellana capensis: Barnard, 1963b: 315.

Description

Shell somewhat domed, with apex anterior to midpoint, circumference narrower at anterior end. Apex eroded in all specimens. Sculpturing consisting of very fine radiating ridges, sometimes slightly granular, often reaching almost to apex.

Material

Numerous examples of external and internal casts. Several incomplete specimens up to 29 mm in diameter. S.A.M. L14187/A.

Remarks

Both sculpturing and general proportions, which have been assessed in some cases by means of silicone casts taken from external casts of shells, agree well with living material. The characteristic colour pattern of the species is naturally entirely lacking. The species occurs alive on the east coast of southern

Africa from East London to Moçambique, Malagasy, and has also been recorded from Pakistan.

Patella granularis Linnaeus

Patella granularis: Koch, 1949: 503. Barnard, 1962: 161.

Material

Several internal casts and several incomplete specimens up to 48 mm in diameter. S.A.M. LI4187/B.

Remarks

The domed shape of the larger specimens and the fine radiating ribs bearing low blunt spines characterize this species, which has been recorded from the Pleistocene of the Namaqualand coast and the Saldanha Bay area. The species occurs alive from southern Angola to Natal.

Family **Fissurellidae**

Diodora parviforata (Sowerby)

Fig. 1

Diodora parviforata: Barnard, 1962: 191; 1963b: 294.

Description

Shell oval in circumference, narrower at posterior end. Foramen small, circular, situated posterior to and slightly below apex. Sculpture consisting of numerous radiating lirae reaching almost from apex to circumference; in upper region growth lines form cancellate pattern with lirae.

Material

One complete specimen, longer diameter 22,8 mm, shorter diameter 15,6 mm, altitude 11,0 mm. S.A.M. LI4187/C.

Remarks

No differences can be detected between the present specimen and living material taken from the west coast. The species has been recorded from the Pleistocene of the Alexander Bay/Port Nolloth area, and living from the west coast of the Cape Peninsula to Port Alfred.

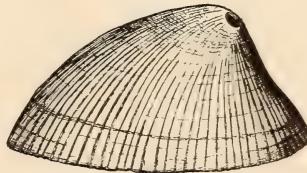


FIG 1. *Diodora parviforata*.

Family **Haliotidae*****Haliotis saldanhae* n.sp.**

Fig. 2

Description

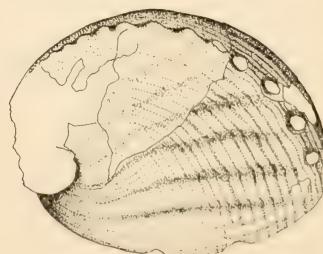
Outer lip of shell margin slightly convex. Four or five foramina present on distinct ridge between upper surface of body whorl and region between foramina and columella ridge. Distinct groove between columella and rest of shell. Body whorl with about 15 smoothly-rounded spiral lirae, some stronger than others. One or two lirae present between larger foramina, nine or ten lirae between foramina and columella, two stronger than rest. Faint growth-lines visible. Several strong smoothly-rounded undulations at angle of about 40° to growth-lines.

Material

HOLOTYPE: an almost complete specimen, 87×63 mm, S.A.M. L14187/D, 2 incomplete and eroded specimens, one with entire body whorl, 117×88 mm. From the second assemblage (see p. 186) a complete internal cast, agreeing well with present species 74×53 mm, S.A.M. L14259/D.

Remarks

Haliotis saldanhae bears some resemblance to both of the present-day species of *Haliotis* which occur around the Cape. In general shape, *H. saldanhae* more closely resembles *H. midae* which is a broader shell than *H. sanguineum*. The outer lip margin is slightly convex as in *H. midae*, rather than slightly concave as in *H. sanguineum*. The foramina of the present species would seem to be fewer in number (4 or 5) and larger than in *H. midae* or *H. sanguineum* of comparable size (8 or 9). The most obvious difference between *H. saldanhae* and the two present-day species lies in the nature of the sculpture; *H. sanguineum* possesses spiral lirae both above and below the foramina (but these are often evanescent in large specimens). This spiral sculpture is rather similar to the present material where it is somewhat stronger. *H. sanguineum* lacks any sculpture other than growth-lines and spiral lirae. *H. midae* characteristically lacks spiral sculpture, but possesses strong oblique undulating raised ridges, whereas the

FIG. 2. *Haliotis saldanhae* n.sp.

present species possesses more widely-spaced oblique undulations, which never reach the raised condition of *H. midae*. A groove is present between the columella and the body whorl in *H. saldanhae*, as in *H. midae*. This is never found in *H. sanguineum*, where the columella merges smoothly with the rest of the shell.

H. tuberculata of the Mediterranean and West Africa is a more elongate species, possesses numerous spiral striae, and lacks any oblique sculpture other than strong growth-lines.

As the present species cannot satisfactorily be reconciled with any fossil or living species of *Haliotis*, it is afforded separate specific status. *H. saldanhae* could perhaps be regarded as ancestral to *H. midae*, given a loss of spiral sculpture, or its obliteration by the oblique undulations, which would become stronger and more closely spaced. The specific name 'saldanhae' is derived from Saldanha Bay, the Pliocene shore having been an extension of this bay.

Family **Trochidae**

Oxystele tigrina (Chemnitz)

Oxystele tigrina: Barnard, 1962: 191; 1963b: 267.

Description

Shell of four whorls, convex in profile, apex damaged or eroded in all specimens. Umbilicus closed. Outer shell layer almost smooth, but broken away in several cases, exposing 10–12 spiral lirae. Latter more distinct in upper whorls, second whorl with seven to nine, third with fewer.

Material

Numerous examples ranging in diameter from 10,0 mm to 31,5 mm (altitude difficult to measure due to damage). S.A.M. LI4187/E.

Remarks

Because of the strength of and similarity in the number of the spiral lirae, the present material is thought to be closest to *O. tigrina*. The material also agrees in general proportions, i.e. altitude to diameter ratio, with this species. The possibility exists that the smaller specimens may belong to a different species, but these too agree well with living material of similar size of *O. tigrina*. The latter has been recorded from the Pleistocene of the Algoa Bay area, and occurs alive from Saldanha Bay to Natal.

Family **Phasianellidae**

Tricolia neritina (Dunker)

Tricolia neritina: Barnard, 1963b: 210.

Material

Numerous examples, largest specimen with diameter of 4,5 mm. S.A.M. LI4187/F.

Remarks

No differences can be detected between the present material and living specimens, which occur from Lüderitzbucht to Algoa Bay.

? Family **Littorinidae**? Genus **Littorina**

Fig. 3

Description

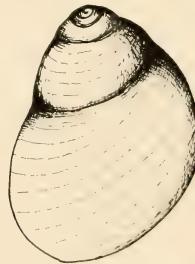
Shell squat, profile evenly convex, with simple protoconch of one whorl, plus $3\frac{1}{2}$ –4 postnatal whorls. Aperture broadly oval. Sculpturing either entirely absent, or with very faint spiral lirae visible on body whorl.

Remarks

The present species, with its lack of characters, could be placed in several families with equal lack of certainty, but would seem closest to *Littorina africana* in overall proportions, in the lack of a strong ridge on the body whorl, and in the faint spiral lirae. There is some superficial resemblance to *Phasianella capensis*, but the greater height of the spire in larger specimens of the latter species seems to discount this identification.

Material

Numerous examples ranging in altitude from 2,5 mm to 7,0 mm. S.A.M. L14187/G.

FIG. 3. ? *Littorina* sp.Family **Muricidae***Ocenebra scrobiculata* (Dunker)

Tritonalia scrobiculata: Barnard, 1959: 212.

Material

One specimen, 6,3 mm altitude. S.A.M. L14187/H.

Remarks

The characteristic cancellate sculpture formed by strong spiral lirae, with nodules formed where these are crossed by axial ridges, agrees perfectly

with the shells of living examples of the species. The nodules do not show the squamae found in the 'crawfordi' form of the species. *T. scrobiculata* has been recorded alive from Saldanha Bay to Natal.

Family **Thaididae**

Thais dubia Krauss

Thais dubia: Barnard, 1959: 221; 1962: 190.

Material

One specimen, apex damaged, altitude 17 mm, diameter 11,0 mm.
S.A.M. LI4187/I.

Remarks

The general form and proportions, the extent of the callus, shape of the columella and the aperture, along with the faint spiral sculpture and obscured axial and growth lines agree well with many specimens of living material of this species. *T. dubia* has been recorded from the Pleistocene deposits of the Namaqualand coast, Knysna, and the Algoa Bay area.

Family **Nassariidae**

Bullia sp.

Material

Several damaged specimens and casts. Largest example altitude 26,8 mm.
S.A.M. LI4187/J.

Remarks

The present species belongs to the group of slender species in the genus, and is very close to *B. digitalis*. Unfortunately, as a callus is not visible on any of the specimens, further identification is not possible.

Family **Turridae**

'*Crassispira*' sp.

Fig. 4

Description

Protoconch $1\frac{1}{2}$ whorls, five postnatal whorls. Basal whorl bearing 15–16 slightly oblique smooth axial ridges, those on outer lip reflecting slight sinuosity of outer lip near suture. Fourth whorl with 12–13 axial ribs, reaching from suture to suture, third whorl with 9–11 axial ribs. Latter difficult to distinguish on earlier whorls due to matrix. Two or three very faint spiral lirae visible on base below axial ribs.

FIG. 4. '*Crassispira*' sp.*Material*

Two complete specimens, altitude 8,9 mm and 7,6 mm, diameter 3,7 mm and 3,5 mm respectively, one with damaged apex. S.A.M. L14187/K and A.

Remarks

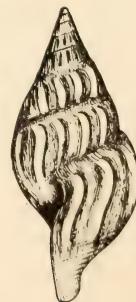
In general proportions, number of whorls, and in the number of axial ribs per whorl, the present material agrees well with *Crassispira hottentota* (see Barnard 1958: 120, and Kilburn 1970: 40). Shells of *C. hottentota* have been collected from False Bay to East London.

'*Clavatula*' sp.

Fig. 5

Description

Shell of six whorls plus protoconch. Outer lip with broad, moderately deep sinus. Sculpturing consisting of oblique, smooth, axial ribs, 12 on basal whorl, 12-13 on fifth whorl, thereafter obscure. Spiral lirae faintly visible on base.

FIG. 5. '*Clavatula*' sp.

Material

Two complete specimens, altitude 9,4 mm and 9,1 mm, diameter 4,9 mm and 4,5 mm respectively. S.A.M. LI4187/L.

Remarks

The generic position of the present material, as with the previous species, is speculative, only the shell being available. Nevertheless, the character of the outer lip sinus suggests a species of *Clavatula* close to *C. sinuata* and its variety *sigillata* (see Barnard 1958: 99).

'*Turris*' sp.

Description

Shell evenly conical, aperture less than half total length. Five whorls plus protoconch. No axial sculpture, basal whorl with 8–10 strong spiral lirae, following whorls each with seven spiral lirae.

Material

One specimen, base damaged, altitude 10,0 mm, diameter 4,4 mm. S.A.M. LI4187/M.

Remarks

With only the shell available, the generic position of the present specimen cannot be verified. The specimen is, however, reminiscent of several species of the genus *Turris*, especially *T. cingulifera*, which it resembles in the spiral sculpture and the aperture shape.

Order OPISTHOBRANCHIATA

Family PYRAMIDELLIDAE

Turbanilla kraussi Clessin

Turbanilla kraussi: Barnard, 1962: 190; 1963a: 84.

Description

Shell slender, tapering, of seven whorls, apical whorl absent. Each whorl bearing numerous smooth axial ridges, about 20 on base, 18–20 on previous whorl.

Material

Two specimens, altitude 5,0 mm and 4,8 mm, diameter 1,9 mm and 1,7 mm respectively, S.A.M. LI4187/N.

Remarks

Because of the small size of the specimens and the hardness of the encrusting matrix, an accurate count of the axial ribs is difficult. Nevertheless, the specimens agree well with living material of similar size. The species has been recorded from the Pleistocene of Sedgefield and the Algoa Bay area, and alive from Saldanha Bay to Natal.

? Family **Pyramidellidae**? Genus **PYRAMIDELLA**

Fig. 6

Description

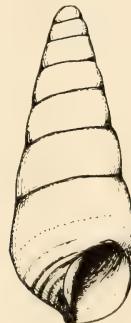
Shell elongate, smoothly conical, protoconch of one whorl, six postnatal whorls, profile of latter very slightly convex, sutures well marked. Aperture wide, columella simple, bearing well-defined callus. Two or three spiral lirae on base, rest of shell lacking sculpture.

Material

Numerous complete specimens up to altitude 9,0 mm, diameter 4,9 mm.
S.A.M. L14187/O.

Remarks

In the simple columella and the general proportions the present material most closely approaches the genus *Turbonilla*, although the number of postnatal whorls (6) is low for the genus. The lack of sculpturing is also not characteristic of the genus, while several species of *Pyramidella* such as *P. ima* Bartsch, and *P. hera* Bartsch, do lack both axial and spiral ornamentation. None of the species, however, has spiral lirae on the base, as occurs in the present material.

FIG. 6. ? *Pyramidella* sp.

Order PULMONATA

Family **Siphonariidae***Siphonaria* sp.

Fig. 7

Description

Circumference of shell oval, outer surface bearing eight or nine strong radial ribs, with weaker ribs between them. Ribs extend beyond circumference of shell. Growth lines faintly visible. Ribs faintly reflected in internal casts, interior with central portion dome-like, with slight groove on one side.

Material

Five specimens, of similar size, largest with longest diameter 13.2 mm, altitude 5.0 mm. S.A.M. Li4187/P.

Remarks

The possibility exists that the present material belongs to the Patellidae, but several factors give an impression of *Siphonaria* rather than *Patella*. These factors include the small size, the raised dome-like central portion with its faint groove possibly indicating the position of the siphon. Of the Patellidae the present material resembles juveniles of *P. longicosta* (and less obviously *P. oculus*) particularly in the external ribbing. The internal doming, however, is unlike these species which are very flat when juveniles. It is also unusual, if these are *Patellas*, that only juveniles of a particular growth size should occur, with no sign of adult specimens, although adults of another species of *Patella* do occur. Of the known species of *Siphonaria*, the present material most closely resembles *S. deflexa* and particularly the variety *cyanomaculata*. This latter species also has strong radial ribs, but usually these are more numerous (15–20 as opposed to 9–12). *S. deflexa* has a present-day distribution from Natal to the Cape Peninsula and has been recorded from the Pleistocene of the Algoa Bay area.

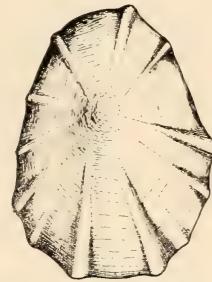


FIG. 7. *Siphonaria* sp.

Class PELECYPODA

Family **Donaciidae**

Donax cf. *serra* (Chemnitz)

Fig. 8

Description

Shell typically donaciform; posterior face set at angle to rest of shell, but not separated by strong ridge, with numerous fine concentric serrulations. Few very faint radial grooves just anterior to posterior face, further radial lines visible below surface layer, margin slightly undulate. Apex smoothly rounded. Maximum apex-to-posterior margin distance only slightly shorter than distance of apex-to-anterior margin.

Material

One complete right valve 27.5 mm × 16.9 mm. S.A.M. L14187/Q.

Remarks

In shells of *Donax serra* of similar total length to the present specimen, the apex-to-posterior distance is obviously shorter than the apex-to-anterior distance. The present specimen is close to being equilateral. The serrulations of the posterior face in similar sized specimens of *D. serra* are stronger and fewer in number than in the present specimen. In spite of these differences, *D. serra* is the species most closely approached. *D. rogersi* (Haughton 1931: 36) from the Pleistocene of the west coast, although almost equilateral, has the posterior area demarcated from the rest of the shell by a strong angular ridge. *D. haughtoni*, also from the Pleistocene of the west coast (Carrington & Kensley 1969: 213) is strongly inequilateral.

The distribution of living *D. serra* is from Walvis Bay to Durban (Barnard 1964) and the species has been recorded from the Pleistocene deposits of Lüderitzbucht, Orange River, Velddrift, and Sedgefield.

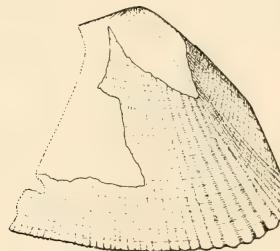


FIG. 8. *Donax cf. serra*

Donax sp.

Fig. 9

Description

Posterior area demarcated from rest of shell by rounded ridge, strong radial grooves and ridges in this region. Numerous faint growth lines visible. Margin slightly serrulate.

Material

One incomplete left valve (posterior portion only). S.A.M. L14187/R.

Remarks

In the strength of the ridges in the posterior region, the angle of the latter to the rest of the shell, and the pattern made by the radial lines and growth lines on the posterior face, the present specimen most closely resembles *Donax aemulus*, a semitropical/tropical species, occurring from Natal to Moçambique

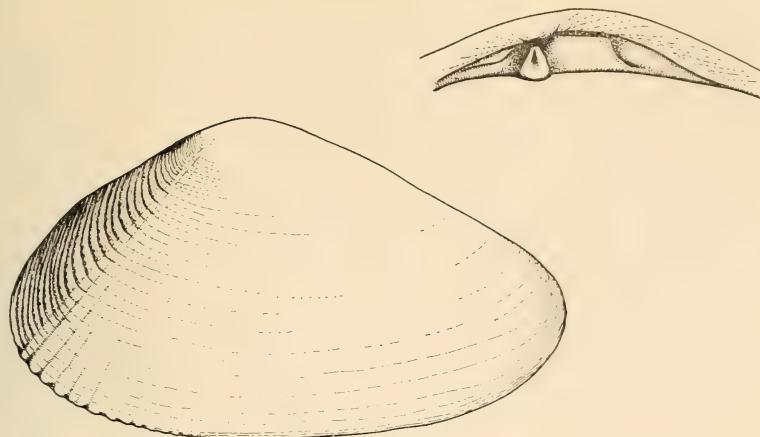


FIG. 9. *Donax* sp. Right valve, external view; right valve, hinge.

and Malagasy. This species has also been recorded from the Pleistocene of Durban.

UNCONSOLIDATED SEDIMENTS (L14259)

Phylum BRACHIOPODA

Kraussina rubra (Pallas)

Kraussina rubra (Pallas), Jackson, 1952: 22.

Material

Numerous external and internal casts, particularly of dorsal valve. S.A.M. L14259/A.

Remarks

Few casts of the external surface of the shell are present, and these are incomplete. The number of radial striae agrees well with this species. The internal casts of the dorsal valve are abundant and quite characteristic, with the branchidium situated between two large eye-like depressions of the umbonal callosity. *K. rubra* occurs alive from Lambert's Bay to the Transkei.

Phylum MOLLUSCA

Class GASTROPODA

Family Patellidae

? *Cellana* sp.

Material

Several complete internal casts and fragments of external casts. S.A.M. L14259/B.

Remarks

The external casts show very fine striations as in *Cellana capensis*, but the material is too incomplete for further comment.

Family **Haliotidae**

Haliotis sp.

Material

Fragments of shell casts, including apex of one shell. S.A.M. L14259/C.
Entire internal cast S.A.M. L14259/D.

Remarks

See p. 176.

Family **Turbinidae**

Turbo sarmaticus Linnaeus

Turbo sarmaticus: Barnard, 1963: 214.

Material

Numerous examples of casts of the operculae. Diameter of operculae up to 24 mm, indicating a shell with a diameter of about 65 mm. Also numerous fragments of internal casts of shells with diameter of individual whorls of up to 28 mm, indicating a shell of about 70 mm diameter. S.A.M. L14259/D.

Remarks

The external, i.e. papillose, surface of the operculum of this species can be deduced as the sandy matrix has filled all the spaces between the papillae. The species has been recorded from the Pleistocene of the Saldanha Bay area, and occurs living from False Bay to the Transkei, and very occasionally from Table Bay and the west coast of the Cape Peninsula.

Class PELECYPODA

Family **Donacidae**

Donax sp.

Material

Two internal casts of left valves, 34 mm and 22 mm in length. S.A.M. L14259/E.

Remarks

The general shape, structure of the hinge (determined from silicone casts) and position of the adductor muscle scars, all agree well with living material of this genus. Without external casts, the specific position is difficult to determine.

Phylum **ECHINODERMATA**

Class ECHINOIDEA

Parechinus angulosus (Leske)*Material*

One almost complete internal cast, 23 mm in diameter, S.A.M. Li4259/F.

Remarks

No differences can be detected between the characteristic internal sculpturing of the ambulacral plates and pores of the present material and that of living material. *P. angulosus* is the most common echinoid living around the Cape, and is usually found on rocky shores.

DISCUSSION

The age of the Langebaanweg marine invertebrate fossils

The relationships of the deposits containing the marine fossils to the rest of the 'E' quarry succession has been one of the more problematical aspects of the local stratigraphy, and it is not intended to enter into a discussion of this in the present paper.

The marine deposit is overlain by an horizon of phosphatic rock, and a layer of non-phosphatic sand and silt, bearing mammalian fossils. The mammalian fauna of this deposit dates from the late Pliocene, and has an inferred age of about 4 million years (Hendey 1970b). Should further work necessitate a change in the age of this mammalian fauna, the inferred age of the marine deposits will also need to be altered.

The loose non-phosphatic sand and silt in which the marine vertebrates occur cannot readily be distinguished from the overlying deposits. These two sets of deposits are regarded as possibly having been accumulated during a single geological episode, with their respective faunas indicating a change in the environment from a marine shoreline to an estuary. The most commonly occurring terrestrial vertebrate (a tortoise) in the non-phosphatic sand and silt is also found in association with the marine vertebrates of the marine deposits, while shark's teeth similar to those which occur in such abundance in the marine deposits are also found. There is no reason to believe that the marine invertebrate assemblage from the site BDT 2/1971 is not contemporaneous with the associated marine vertebrates at the same level. This assemblage is thus regarded as broadly contemporaneous with the mammalian fauna from the overlying deposits.

It is less certain that the marine invertebrates from the cemented phosphatic matrix (Li4187) are contemporaneous with the marine vertebrates which occur in the unconsolidated sediments at the same level. The shark's

teeth recovered from the cemented matrix, however, are similar in type and preservation to those of the unconsolidated sediments. (In how far these teeth may be used to indicate contemporaneity is uncertain, as these forms cover a time span from the Cretaceous to recent times.) The two invertebrate assemblages do have certain genera and possibly also species in common. The indications are that these two assemblages are similar in age, and that they both date from the Upper Pliocene. The differences in preservation and in the nature of the matrices may simply reflect deposition under differing conditions rather than geologically significant temporal separation. The two assemblages have nevertheless been treated separately as their contemporaneity has not been proved.

The marine deposits of 'E' quarry are underlain by a clay of undetermined thickness, the age and origin of which is unknown, and thus sheds no additional light on the age of the marine fauna.

Reports on the Tertiary of southern Africa are few in number and of a descriptive nature. Haughton (1926, 1932), in discussing the fossil mollusc faunas of the west coast, came to the conclusion that these were of late Tertiary age and correlated them with the Alexandria Beds of Redhouse, in the Zwartkops area of the east coast. These latter beds were described by Newton (1913) as being of Mio-Pliocene age. It is now considered that the west coast deposits discussed by Haughton are of Pleistocene age (Carrington & Kensley 1969: 190-191). None of the forms mentioned by Newton have been found in the present material.* Cox (1939) reported on the Tertiary and Post-Pliocene deposits of Inhambane, Moçambique. The material mentioned is very typically of Indian Ocean affinity, and has nothing in common with the present material.

BRIEF ECOLOGICAL COMMENTS

From the species list (Table 1) it may be seen that both assemblages contain rock- as well as sand-dwelling forms. Amongst the phosphatic matrix assemblage, only the two species of *Donax* and the single species of *Bullia* are sand-dwellers. All the other species are either permanently attached to a rocky substrate (the acorn barnacles, which are too fragmentary for identification), or grazers found on rocky shores or on algae attached to rocks (the patellids *Oxystele*, *Haliotis*, *Littorina*, *Tricula*, *Siphonaria*, *Diodora*), or are carnivores found in rock pools or under stones (*Tritonalia*, 'Clavatula', 'Turris', 'Crassispira', *Thais*). Of these, the species tentatively placed in *Littorina* is the most abundant (although little quantitative importance can be attached to a single 'cluster' of fossil shells). It seems quite likely that the Pliocene shore in the area under discussion had both rocky and sandy components. The second most abundant species is that tentatively placed in the Pyramidellidae. Comparatively little is known of the ecology of these forms, many of which are probably commensals or parasites of other invertebrates.

* Engelbrecht *et al.* (1962) record *Donax serra* from the Tertiary Alexandria Beds.

TABLE I
List of species from both assemblages

CEMENTED PHOSPHATIC MATRIX (L14187)		UNCONSOLIDATED SEDIMENTS (L14259)	
MOLLUSCA: GASTROPODA		BRACHIOPODA	
Bullia sp.	S	<i>Kraussina rubra</i>	R
<i>Cellana capensis</i>	R	MOLLUSCA: GASTROPODA	
'Clavatula' sp.	R	? <i>Cellana</i> sp.	R
'Crassispira' sp.	R	<i>Haliotis</i> sp.	R
<i>Diodora parviforata</i>	R	<i>Turbo sarmaticus</i>	R
<i>Haliotis saldanhae</i>	R	MOLLUSCA: PELECYPODA	
? <i>Littorina</i> sp.	R	<i>Donax</i> sp.	
<i>Ocenebra scrobiculata</i>	R	ECHINODERMATA: ECHINOIDEA	
<i>Oxystele tigrina</i>	R	<i>Parechinus angulosus</i>	R
<i>Patella granularis</i>	R		
? <i>Pyramidella</i> sp.	R		
<i>Siphonaria</i> sp.	R		
<i>Thais dubia</i>	R		
<i>Tricolia neritina</i>	R		
<i>Turbanilla kraussi</i>	R		
'Turris' sp.	R		
MOLLUSCA: PELECYPODA			
<i>Donax cf. serra</i>	S		
<i>Donax</i> sp.	S		
ARTHROPODA:			
CRUSTACEA: CIRRIPEDIA			
Acorn barnacle fragments	R		

R = rock-dwelling

S = sand-dwelling

Amongst the unconsolidated sediment assemblage, only the *Donax* is a sand-dweller. The other species are sessile on rocks (*Kraussina*) or are herbivorous forms found on rocks (*Haliotis*, *Cellana*, *Turbo*). Judging from the number of casts of *Turbo* operculae, this species must have been fairly abundant.

Three genera, viz. *Haliotis*, *Cellana* and *Donax*, appear in both assemblages. Whether these included the same species is difficult to decide, due to the poor state of the sandy matrix material.

It is interesting to note that *Cellana capensis* at present only occurs northwards from East London, and that *Turbo sarmaticus* (with the rare exceptions mentioned above) occurs eastwards from False Bay. This may indicate a somewhat higher sea temperature on the west coast during the Pliocene than obtains at present.

Although several of the fossil forms have been identified with extant species, it is possible that some of the specimens are representatives of extinct species. Further material and more detailed work will clarify the situation.

SUMMARY

22 fossil mollusc forms including a new species of *Haliotis*, one species of brachiopod and one species of echinoderm are recorded from two assemblages from Langebaanweg, Cape Province. The age of the fossils is deduced by correlation of the overlying mammalian fauna with that of East Africa, as dating from the Upper Pliocene.

ACKNOWLEDGEMENTS

My grateful thanks are due to Mr Q. B. Hendey, of the South African Museum, for providing the material for the present paper, and also for supplying the information concerning the geological position and age of the fossils.

I am indebted to Mr G. Branch and Professor A. C. Brown, both of the Department of Zoology, University of Cape Town, for comments on the patellids and *Bullia* respectively, to Dr P. A. Hulley of the South African Museum for information concerning the fossil shark teeth, and to Mr A. Tankard for comments on the manuscript. Finally, my sincere thanks are due to Mrs Ione Rudner, without whose careful and very thorough preparation of the fossils this work would not have been possible.

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Example

Scalaria coronata Lamarck, 1816: pl. 451, figs 5 *a*, *b*; Liste: 11. Turton, 1932: 80.

Brian Kensley

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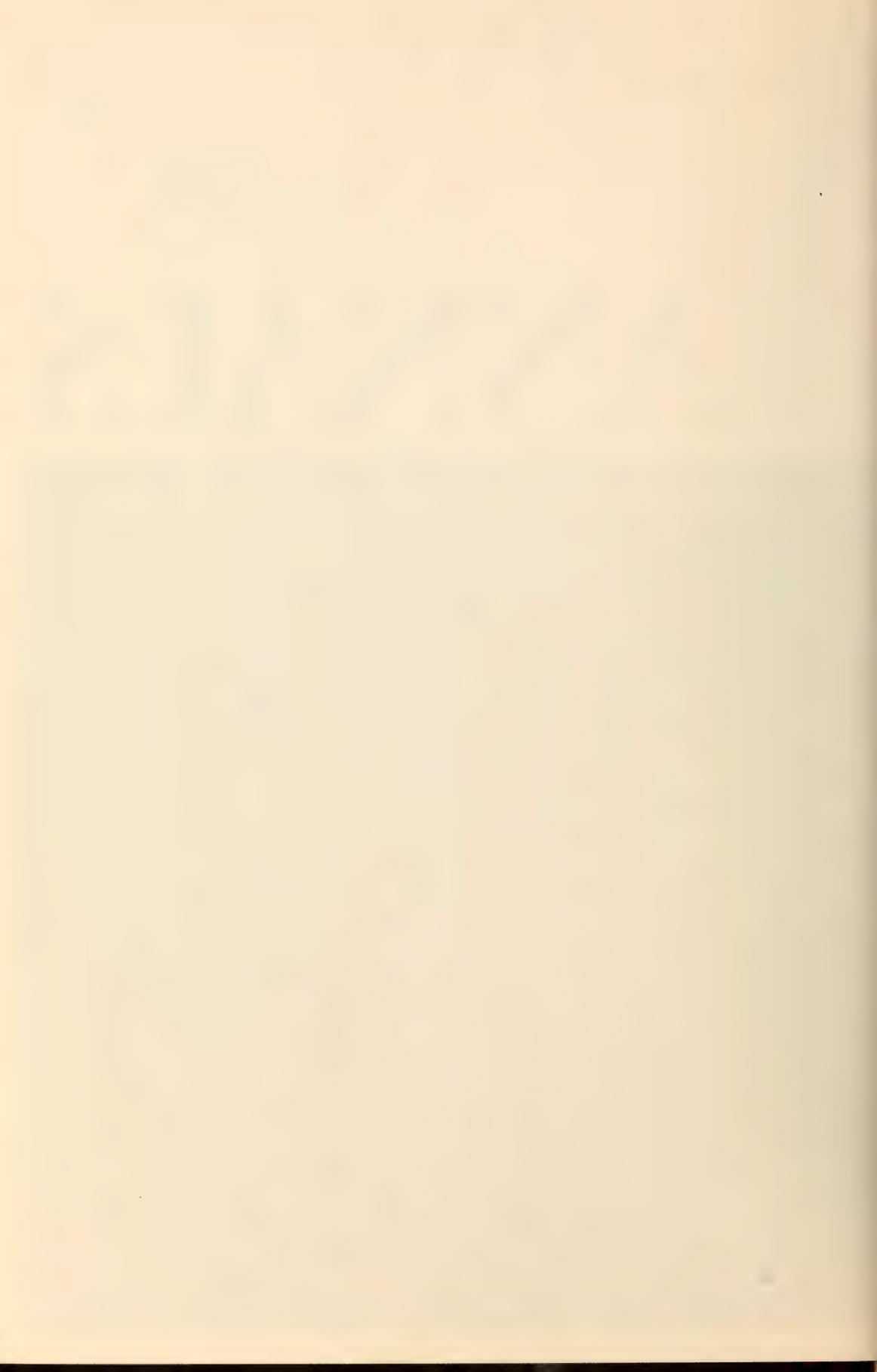
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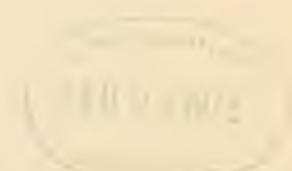
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THE RARE PLECTOGNATH FISH,
MACRORHAMPHOSODES URADOI (KAMOHARA)
(TRIACANTHODIDAE) IN SOUTH AFRICAN WATERS

By
P. A. HULLEY

Cape Town Kaapstad



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1, 2(1, 3, 5, 7-8), 3(1-2, 5, t.-p.i.), 5(1-2, 5, 7-9),
6(1, t.-p.i.), 7(1-3), 8, 9(1-2), 10(1),
11(1-2, 5, 7, t.-p.i.), 24(2), 27, 31(1-3), 33

Price of this part/Prys van hierdie deel

R 1,20

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1972

ISBN 0 949940 19 4

Printed in South Africa by
The Rustica Press, Pty., Ltd,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

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By

P. A. HULLEY

(South African Museum, Cape Town)

(With 2 figures)

[Ms. accepted 20 June 1972]

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INTRODUCTION

Among a large quantity of material donated to the South African Museum in 1971 by the skipper of the Cape Town-based trawler *Lobelia*, was a single example of a long-snouted triacanthodid fish. Unfortunately, during transport at sea, the tip of the snout of the specimen was damaged, being compressed between the lid and side walls of the canister, so that characters associated with this region (mouth width, degree of twisting of the mouth) are difficult to interpret. However, the specimen has been identified as *Macrorhamphosodes uradoi* (Kamohara, 1933), and as such represents not only the first record of the species in the southern African region, but also the first record outside the waters of Japan. It therefore sheds new light on the factors affecting the geographical isolation of the species as suggested by Tyler (1968).

Two genera of long-snouted triacanthodid fishes, *Macrorhamphosodes* and *Halimochirurgus*, are recognized at present (Tyler 1968), and are easily distinguished from each other by snout width, twisting of the mouth, teeth shape, and the length of the third dorsal spine. The specimen falls within the genus *Macrorhamphosodes* by virtue of its flattened spatulate teeth, especially in the lower jaw, and because the third dorsal spine is well developed, its length being 0.76 the length of the second dorsal spine (Figs 1, 2).

The specimen has been identified as *M. uradoi*, and may be distinguished from the closely related *M. platycheilus* Fowler, 1934 by its extremely short gill opening, which extends ventrally to a level of about one-third down the pectoral base (Fig. 1), dental formula and fin count. Furthermore, the pre-maxillary pedicels are elongated into thin filaments (Fig. 2) and the maxillaries,

which are difficult to distinguish in the crushed snout, are comparatively narrow (Fig. 2).

In view of this record, it would appear that the distribution of *M. uradoi* is much wider than previously thought, and that like its congener *M. platycheilus*, it bridges the Indonesian region to achieve an Indo-West Pacific distribution pattern. *M. platycheilus* has recently been reported from East African waters (Tyler 1970).



FIG. 1. *Macrorhamphosodes uradoi* (SAM 26308). A. Lateral view; B. Ventral view.

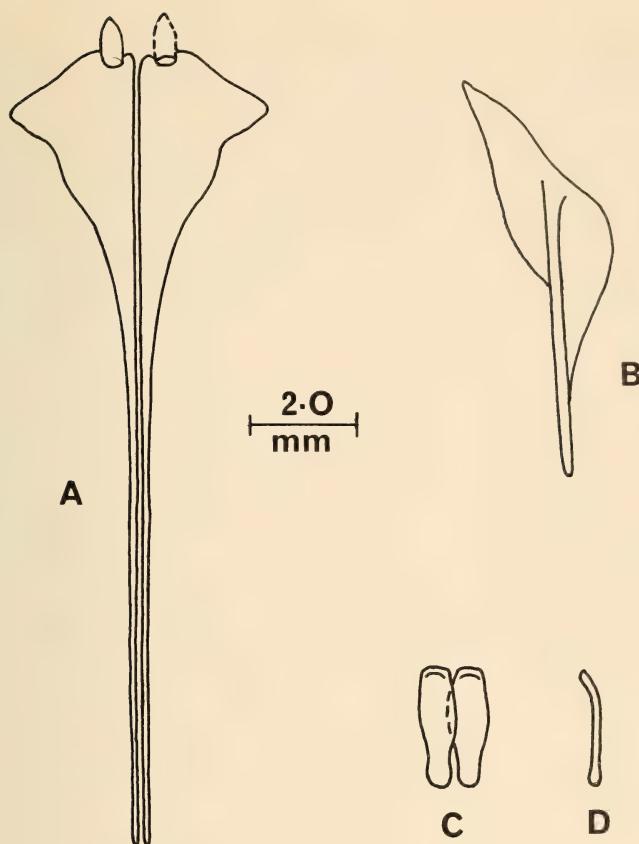


FIG. 2. *Macrorhamphosodes uradoi* (SAM 26308). A. Premaxillaries; B. Left maxillary; C. Lower teeth (dorsal view); D. Lower tooth (vertical cross-section).

DESCRIPTION OF MATERIAL

Macrorhamphosodes uradoi (Kamohara, 1933)

Halimochirus uradoi Kamohara, 1933: 392, figs 1-3.

Macrorhamphosodes uradoi: Kamohara, 1937: 7, pl. 1, fig. 2; 1938: 43; 1952: 61; 1958: 51; 1961a: 5; 1961b: 39, pl. 39, fig. 5; 1964: 67. Fraser-Brunner, 1950: 5. Tomiyama & Abe, 1958: 29, fig. Tyler, 1968: 194, figs 73-79, 204.

Material

One specimen, SAM 26308 (S.L. c. 165 mm), trawled off Bird Island, Port Elizabeth ($33^{\circ}58'S$; $25^{\circ}40'E$), in 220-240 fms (400-450 metres).

Description

Proportional dimensions are not given, as the snout of the specimen is badly damaged.

D III, 14; A 12; P 13; V I; C 12. Vertebral count 20.

Body elongate and laterally compressed; caudal peduncle long, its width 1,7 in peduncle length. Eye large, interorbit 1,7 in largest diameter of eye. Snout elongate, forming tube (anterior region of snout damaged); premaxillaries with long, filamentous pedicels, maxillaries comparatively narrow. 2 teeth in upper jaw (1 broken), flattened but tapering to blunt point; 8 spatulate teeth in lower jaw (\pm 3 missing), compressed and slightly curved distally. Gill slit small, extending ventrally to about one-third level down pectoral base, its length 4,6 in largest diameter of eye. Origin of dorsal above pectoral base; 1st spine with asperities to about one-half its length, extending a little beyond tip of 2nd spine, but falling short of origin of soft dorsal; 3rd dorsal spine well developed, its length 76,7% the length of 2nd spine. Pectoral situated below midline of body, its rays extending posteriorly beyond origin of 3rd dorsal spine. Ventral origin below posterior base of pectoral; pelvic equal in length to 1st dorsal spine, with minute filament in axil; pelvis much wider anteriorly and tapering to a point posteriorly, its ventral surface broad and flattened. Anal origin below 5th soft dorsal ray; caudal rounded. Scales with asperities.

Colour: (in alcohol) yellowish-tan, somewhat darker above than below; edges of fins tinged pink.

Distribution

Southern Japan to South Africa in 100–240 fms (183–450 m).

SUMMARY

A specimen of the rare triacanthodid fish, *Macrorhamphosodes uradoi* (Kamohara, 1933) is described from the southern African region. This represents not only the first record in this region, but also the first record outside Japanese waters. Its depth distribution is increased to between 400 metres and 450 metres.

ACKNOWLEDGEMENTS

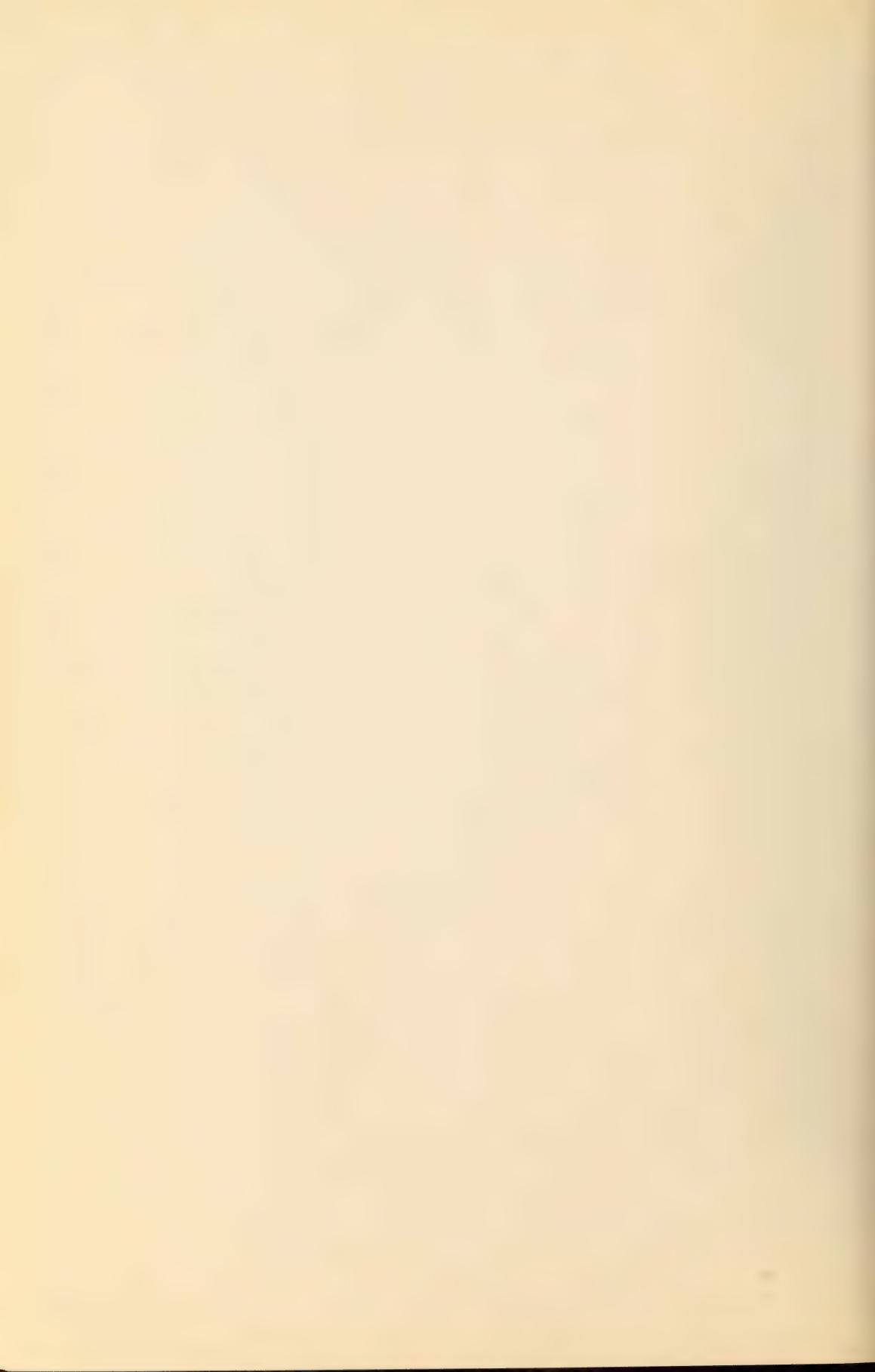
I should like to express my thanks to Capt. Olivari and crew of the M/T *Lobelia* for the many interesting specimens they have donated to the South African Museum, and to Mr S. X. Kannemeyer, of this Department, for his assistance.

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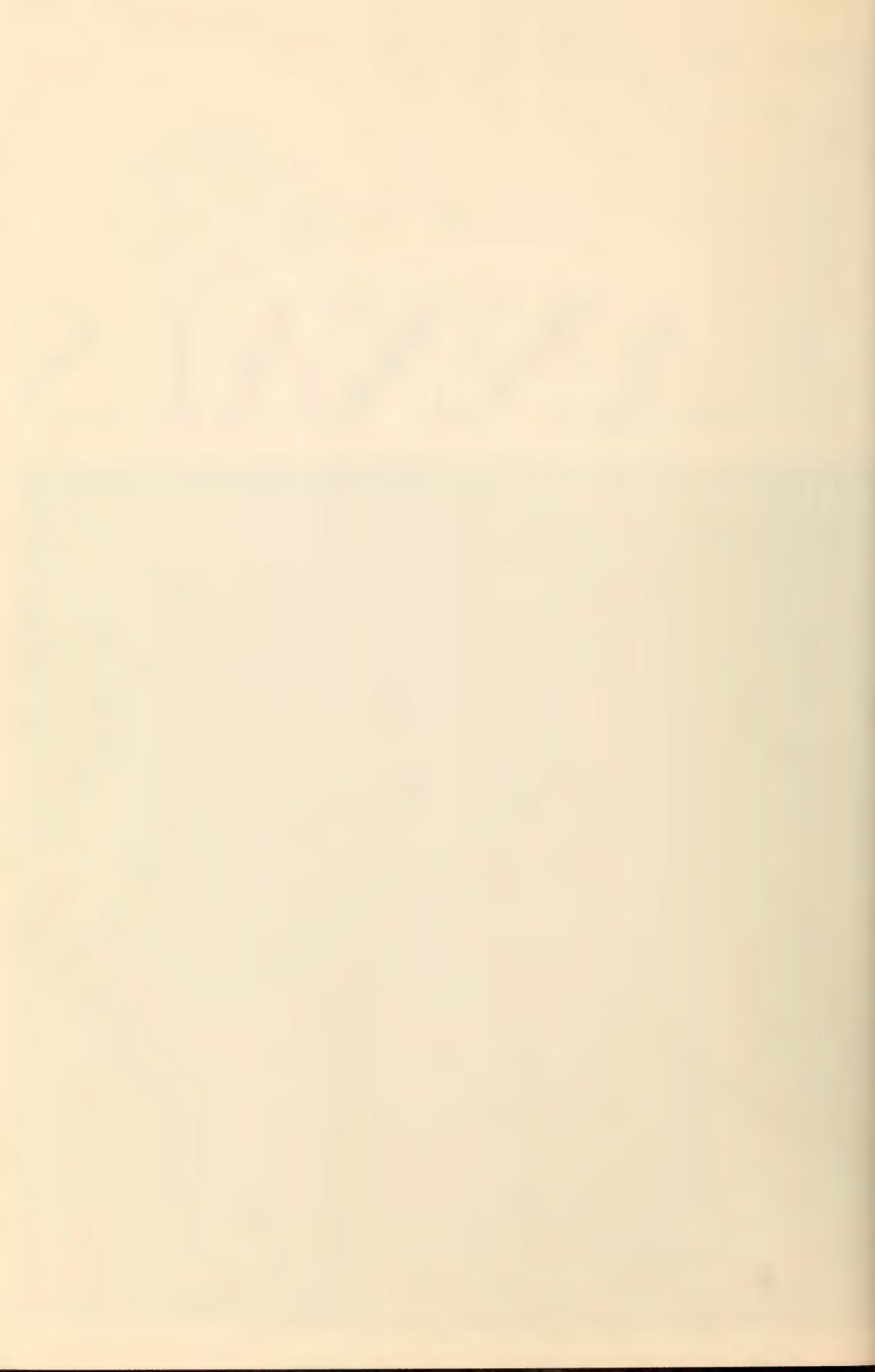
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COLLECTED DURING THE DEEP-SEA CRUISES
OF R.S. 'AFRICANA II', 1961-1966

By
P. A. HULLEY

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The ANNALS OF THE SOUTH AFRICAN MUSEUM

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Die ANNALE VAN DIE SUID-AFRIKAANSE MUSEUM

word uitgegee in dele op ongereelde tye na beskikbaarheid
van stof

Verkrygbaar van die Suid-Afrikaanse Museum, Posbus 61, Kaapstad

OUT OF PRINT/UIT DRUK

1, 2(1, 3, 5, 7-8), 3(1-2, 5, t.-p.i.), 5(1-2, 5, 7-9),
6(1, t.-p.i.), 7(1-3), 8, 9(1-2), 10(1),
11(1-2, 5, 7, t.-p.i.), 24(2), 27, 31(1-3), 33

Price of this part/Prys van hierdie deel

R3,50

Trustees of the South African Museum © Trustees van die Suid-Afrikaanse Museum
1972

ISBN 0 949940 20 8

Printed in South Africa by
The Rustica Press, Pty., Ltd,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

A REPORT ON THE MESOPELAGIC FISHES COLLECTED DURING
THE DEEP-SEA CRUISES OF R.S. 'AFRICANA II', 1961-1966

By
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South African Museum, Cape Town

(With 3 figures and 1 table)

[*Ms. accepted 20 June 1972*]

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INTRODUCTION

In 1960, an investigation on the composition of the mesopelagic fauna of the southern African region was instigated by Dr F. H. Talbot, formerly of the South African Museum, as part of the survey of the biology of tuna. The original intention was to build up a reference collection of possible forage organisms of tunas, but the survey was expanded by the Division of Sea Fisheries, as part of their biological programme, to incorporate an intensive survey of the mesopelagic fauna of the region.

As far as the ichthyofauna is concerned, it appears that the southern African region has been fairly well sampled during cruises of the S.S. *Pieter Faure*, S.S. *Pickle* and R.V. *Discovery*, while stations in the area were occupied by the *Valdivia*, *Dana* and Deutsche Südpolar Expedition. Recently, an investigation of the entire area was carried out by the South African Museum (Grindley & Penrith 1965), while the western South Indian Ocean was covered during Cruises 3 and 6 of R.V. *Anton Bruun*, and the eastern South Atlantic Ocean by the R.V. *Walter Herwig* and the SRTM *Vyandra*.

This paper is intended only as a general supplement to the above work, so that detailed taxonomic descriptions and synonymies are not given. The hydrography of the southern African region is comparatively well known and has been adequately summarized by Grindley & Penrith (1965).

The midwater collections, on which this paper is based, were obtained

during six cruises of R. S. *Africana II*, from 1961 to 1966 (Fig. 1). A total of 146 stations were occupied during the cruises and fishing was undertaken at 60 of these. However, material from only 48 stations was sent to the South African Museum for identification. Details of the position, estimated fishing depth, fishing time, time of day and gear for the relevant stations are given below in the Station List. The majority of hauls were made during the day, either with an N200B net (1961-3) or Isaacs-Kidd Midwater Trawl (1964-6), but at several stations during the 1964 Cruise, an Isaacs-Kidd Midwater Trawl adapted with an N200 ring at the codend was employed.

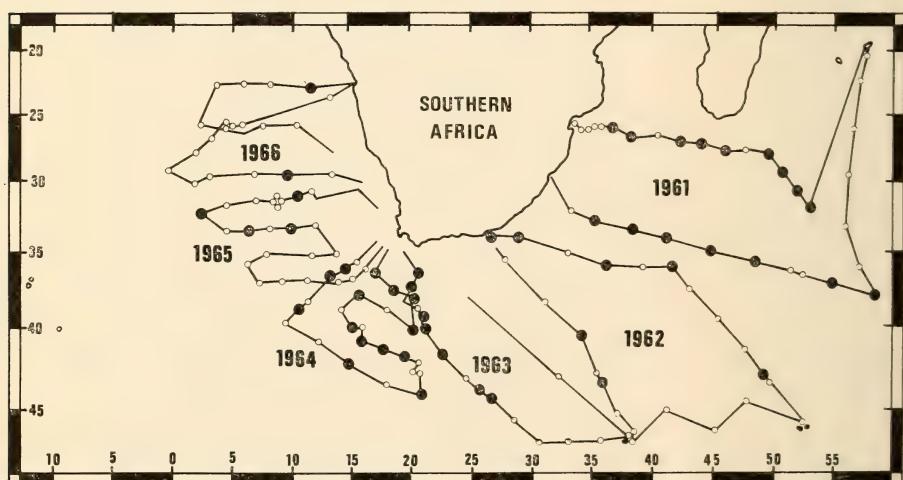


FIG. 1. Stations occupied during the Deep-sea Cruises of R.S. *Africana II* from 1961 to 1966 (● fishing stations).

The material, which included mostly juveniles to adults and only a few larval fishes, was given to the South African Museum for identification, and has now been incorporated into the collection of this institution.

Fishes of the family Paralepididae have not been included in this paper, while specific identifications of the Melamphaeidae, Scopelosauridae and Cyclothonidae have not been undertaken.

The species list, based on these collections, has been divided into three regions for convenience:

- (i) South East Atlantic—stations west of 19°E (St A 2945-53; 2958-63; 2967-8; 3616-43; 4218-34).
- (ii) South of Agulhas—stations between 19°E and 26°E (St A 2386-94; 2957; 2965-6).
- (iii) South West Indian—stations east of 26°E (St A 1225-54; 1877-96).

STATION LIST

Year	Date	Station No	Position	Gear	Fishing time (mins)	Time of day	Depth (metres)
1961	14-VI	A 1225*	25°55'S, 33°33'E	N200B	24	1250-1314	300-0
	14-VI	A 1226*	25°56'S, 34°06'E	"	23	1616-1640	"
	15-VI	A 1227*	26°09'S, 34°30'E	"	23	0958-1021	"
	15-VI	A 1228*	26°08'S, 35°06'E	"	23	1430-1453	"
	16-VI	A 1229	26°12'S, 36°12'E	"	27	1725-1752	"
	17-VI	A 1230	26°42'S, 37°41'E	"	13	1835-1850	250-0
	19-VI	A 1232	27°10'S, 41°45'E	"	19	1908-1927	"
	20-VI	A 1233	27°22'S, 43°35'E	"	23	1630-1653	"
	21-VI	A 1234	27°47'S, 45°41'E	"	25	1720-1745	"
	22-VI	A 1235*	27°48'S, 47°19'E	"	18	1750-1808	"
	23-VI	A 1236	28°11'S, 49°20'E	"	83	1635-1755	"
	24-VI	A 1237	29°29'S, 50°30'E	"	120	1625-1830	1 000-500-0
	25-VI	A 1238	30°50'S, 51°36'E	"	125	1620-1825	"
	26-VI	A 1239	32°07'S, 52°49'E	"	90	1600-1730	"
	6-VII	A 1245*	36°16'S, 56°45'E	"	55	1404-1459	500-0
	7-VII	A 1246	37°43'S, 57°17'E	"	60	1715-1815	"
	8-VII	A 1247	37°17'S, 54°36'E	"	87	1621-1748	1 500-0
	10-VII	A 1250	35°48'S, 47°37'E	"	68	1637-1745	500-0
	11-VII	A 1251	34°57'S, 44°00'E	"	65	1635-1740	"
	12-VII	A 1252	34°14'S, 40°46'E	"	55	1500-1555	"
	13-VII	A 1253	33°35'S, 37°51'E	"	80	1115-1235	"
	13-VII	A 1253	33°25'S, 37°07'E	"	65	1640-1745	"
	14-VII	A 1254	33°01'S, 34°49'E	"	100	1110-1250	"
	14-VII	A 1254	33°01'S, 34°49'E	"	60	1630-1730	"
1962	23-VI	A 1877	40°44'S, 33°36'E	"	90	1330-1500	820-0
	24-VI	A 1879	43°39'S, 35°14'E	"	130	1635-1845	1 000-0
	25-VI	A 1880*	45°25'S, 36°32'E	"	100	1355-1535	500-0
	26-VI	A 1881*	46°40'S, 38°00'E	"	45	1000-1045	300-0
	27-VI	A 1882*	46°58'S, 37°56'E	"	45	1630-1715	100-0
	3-VII	A 1888	43°17'S, 48°55'E	"	110	1615-1805	1 000-0
	7-VII	A 1892	36°28'S, 41°22'E	"	117	1348-1545	"
	9-VII	A 1894	36°02'S, 35°38'E	"	55	1611-1706	500-0
	11-VII	A 1896	34°12'S, 28°24'E	"	80	1520-1640	1 000-0
	3-IV	A 2386	36°33'S, 20°01'E	"	56	1357-1453	500-0
1963	4-IV	A 2387	37°36'S, 19°34'E	"	75	1625-1740	823-0
	5-IV	A 2389	ca39°01'S, 20°04'E	"	30	1917-1947	820-0
	6-IV	A 2390	40°18'S, 20°26'E	"	30	1345-1415	823-0
	7-IV	A 2391	41°59'S, 21°59'E	"	65	1330-1435	820-0
	8-IV	A 2393	43°50'S, 25°00'E	"	73	1832-1945	"
	9-IV	A 2394	44°40'S, 26°05'E	"	30	1315-1345	"
	11-III	A 2945	36°11'S, 14°14'E	IKMT	90	2000-2130	700-0
1964	13-III	A 2948	39°00'S, 10°12'E	"	113	1952-2145	"
	15-III	A 2950*	41°05'S, 11°41'E	"	165	1415-1700	"
	16-III	A 2951	42°28'S, 14°25'E	IKMT+	140	1340-1600	"
	18-III	A 2953	44°24'S, 20°16'E	IKMT	180	1100-1400	600-0
	19-III	A 2957	42°11'S, 19°26'E	"	120	1930-2130	700-0
	20-III	A 2958	41°40'S, 17°17'E	IKMT+	170	1425-1715	600-0
	22-III	A 2961	40°12'S, 14°41'E	IKMT	105	1840-2025	700-0
	23-III	A 2962	39°06'S, 13°34'E	IKMT+	—	1300-	600-0
	24-III	A 2963	38°00'S, 15°00'E	"	135	1500-1715	"
	26-III	A 2965	40°17'S, 15°54'E	"	135	1615-1830	"
	27-III	A 2966	38°09'S, 16°50'E	"	271	1255-1726	"
	28-III	A 2967	37°45'S, 18°00'E	"	120	1400-1600	"

Year	Date	Station No	Position	Gear	Fishing time (mins)	Time of day	Depth (metres)
1965	29-III	A 2968	36°38'S, 16°28'E	"	—	—	"
	7-IV	A 3616	31°19'S, 10°08'E	IKMT	225	1525-1910	1 000-0
	13-IV	A 3630	32°31'S, 01°55'E	"	167	1313-1600	"
	15-IV	A 3632	33°41'S, 05°54'E	"	135	1700-0915	1 000-500-0
	16-IV	A 3634	33°23'S, 09°31'E	"	110	1610-1800	"
1966	23-IV	A 3643	36°51'S, 12°43'E	"	120	0930-1130	1 000-0
	8-VII	A 4218	29°30'S, 10°03'E	"	60	1325-1425	1 400-0
	18-VII	A 4229	23°25'S, 11°39'E	"	60	0910-1010	600-0
	22-VII	A 4234*	26°06'S, 13°02'E	"	60	1050-1150	375-0

IKMT⁺ = IKMT adapted with N200 ring

* = material not received from these Stations

SPECIES LIST

	South East Atlantic	South of Agulhas	South West Indian
Searsiidae			
<i>Persparsia kopua</i>	+		+
Gonostomatidae			
<i>Valencienellus tripunctulatus</i>	+		+
<i>Vinciguerria nimbaria</i>	+	+	+
<i>Vinciguerria attenuata</i>	+	+	+
<i>Photichthys argenteus</i>	+	+	+
<i>Gonostoma atlanticum</i>		+	
<i>Gonostoma elongatum</i>	+		
<i>Gonostoma bathyphilum</i>	+		
<i>Cyclothona</i> spp.	+	+	+
Sternopytchidae			
<i>Argyropelecus gigas</i>	+		
<i>Argyropelecus aculeatus</i>	+	+	+
<i>Argyropelecus hemigymnus</i>	+	+	+
<i>Sternopyx diaphana</i>	+	+	+
Stomiatidae			
<i>Stomias boa</i> <i>boa</i>	+		+
Chauliodontidae			
<i>Chauliodus sloani</i>	+	+	+
Astronesthidae			
<i>Astronesthes indicus</i>		+	
<i>Neonesthes capensis</i>	+	+	
Melanostomiataidae			
<i>Echiostoma barbatum</i>			+
<i>Leptostomias gladiator</i>			+

	South	East	South	of	South	West
	Atlantic		Agulhas		Indian	

<i>Eustomias</i> sp.	.	.	.	.		+
<i>Opostomias gibsonpacei</i>	.	.	.	.	+
<i>Flagellostomias boureei</i>	.	.	.	+		
<i>Bathophilus ater</i>	.	.	.	+		
<i>Pachystomias microdon</i>	.	.	.	+		

Malacosteidae

<i>Malacosteus niger</i>	.	.	.	+	+	
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Idiacanthidae

<i>Idiacanthus fasciola</i>	.	.	.	+		
<i>Idiacanthus atlanticus</i>	.	.	.	+		
<i>Idiacanthus</i> sp.	+	

Bathylagidae

<i>Bathylagus antarcticus</i>	.	.	.	+	+	
<i>Bathylagus bericoides</i>	.	.	.	+		

Scopelarchidae

<i>Neoscopelarchoides elongatus</i>	.	.	+			
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Scopelosauridae

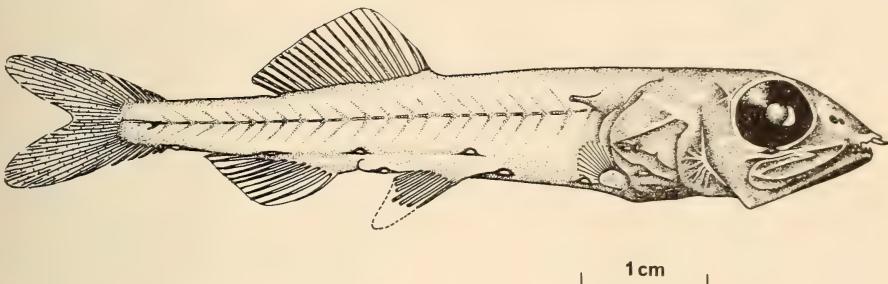
<i>Scopelosaurus</i> sp.	.	.	.	+	+	
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Myctophidae

<i>Protomyctophum</i> (<i>Protomyctophum</i>) <i>anderssoni</i>		+
<i>Protomyctophum</i> (<i>Protomyctophum</i>) <i>normani</i>	+	
<i>Protomyctophum</i> (<i>Protomyctophum</i>) <i>bolini</i>	.	.	.	+	+	+
<i>Protomyctophum</i> (<i>Protomyctophum</i>) <i>andriashevi</i>	.	.	.	+		
<i>Protomyctophum</i> (<i>Hierops</i>) <i>paral-</i> <i>lelum</i>	.	.	.	+		
<i>Protomyctophum</i> (<i>Hierops</i>) <i>sub-</i> <i>parallelum</i>	.	.	.	.	+
<i>Electrona antarctica</i>	.	.	.			+
<i>Electrona rissoii</i>	.	.	.	+		
<i>Benthosema suborbitale</i>	.	.	.		+	+
<i>Diogenichthys atlanticus</i>	.	.	.	+	+	+
<i>Hygophum proximum</i>	.	.	.			+
<i>Hygophum hygomi</i>	.	.	.			+
<i>Hygophum hansenii</i>	.	.	.	+		
<i>Symbolophorus boops</i>	.	.	.	+		
<i>Notolychnus valdiviae</i>	.	.	.		+	+
<i>Lampadена notialis</i>	.	.	.	+		

			South East Atlantic	South of Agulhas	South West Indian
<i>Lampanyctus alatus</i>	.	.	+	+	+
<i>Lampanyctus australis</i>	.	.	+	+	
<i>Lampanyctus pusillus</i>	.	.	+		+
<i>Lampanyctus ater</i>	.	.	+		
<i>Lampanyctus cf. achirus</i>	.	.	+		
<i>Lepidophanes indicus</i>	.	.	+		+
<i>Ceratoscopelus warmingi</i>	.	.	+		+
<i>Lobianchia dofleini</i>	.	.	+		
<i>Diaphus cf. theta</i>	.	.	+	+	
<i>Diaphus ostenfeldi</i>	.	.	+		
<i>Scopelopsis multipunctatus</i>	.	.	+		+
Bregmacerotidae					
<i>Bregmaceros mcclellandi</i>	.	.	+		
Melanonidae					
<i>Melanonus gracilis</i>	.	.	+	+	+
Trachipteridae					
<i>Trachipterus sp.</i>	.	.	+		
Melamphaeidae (sensu latu)	.	.	+	+	+
Diretmidae					
<i>Diretmus argenteus</i>	.	.	+		+
Scombropidae					
<i>Howella brodiei</i>	.	.	+	+	
Chiasmodontidae					
<i>Chiasondon niger</i>	.	.	+		
Bramidae					
<i>Pterycombus cf. petersii</i>	.	.			+
Brotulidae					
<i>Neobythites macrops</i>	.	.	+		
Gempylidae					
<i>Epinnula orientalis</i>	.	.			+
Ceratiidae					
<i>Cryptopsaras couesii</i>	.	.	+		
Scorpaenidae					
<i>Helicolenus dactylopterus</i>	dactylop- terus	.	+		
Nemichthyidae					
<i>Borodinula infans</i>	.	.	+	+	
<i>Nemichthys scolopaceus</i>	.	.		+	
Serrivomeridae					
<i>Serrivomer beanii</i>	.	.	+		

SYSTEMATIC DISCUSSION

Family **Searsiidae***Persplesia kopua* (Phillips, 1942)FIG. 2. *Persplesia kopua* (Phillips, 1942).

Bathytroctes kopua Phillips, 1942: 49, pl. 16, fig. 1.
Persplesia kopua Parr, 1960: 48, fig. 33. Matsui & Rosenblatt, 1971: 447.
Bathytroctes rostratus Norman, 1930: 268, fig. 1, pl. 2, fig. 3.
Persplesia taningi Parr, 1951: 18; 1960: 50, figs 35, 36. Tucker, 1954: 208 (*partim*).

Material

- SAM 26143, 1 (18.5), St A 1247, 1 500-0 m.
 SAM 26144, 1 (30), St A 2968, 600-0 m.
 SAM 26145, 1 (64), St A 4218, 1 400-0 m.

Description

D 21; A 14; P 20; V 8 (9); gill-rakers 34-35. Photophore distribution given in Table I.

Remarks

Although the specimens fit the description of *P. taningi*, it is now held that this species is synonymous with *P. kopua*, and that differences in photophore distribution and the calcified support to the shoulder organ represent ontogenetic changes (Matsui & Rosenblatt 1971). These specimens possess laterally directed teeth on the premaxilla, so that it is considered that this is a character which is lost with growth.

TABLE I

Persplesia kofua. Photophore distribution (terminology according to Parr 1960).

	SAM 26143 (SL 18.5 mm)	SAM 26144 (SL 30 mm)	SAM 26145 (SL 64 mm)
GO ₁	.	.	?
GO ₂	.	.	?
IOO	.	.	+
POO	.	.	—
BRO (7)	.	.	?
PJO	.	.	—
JO	.	.	+
IPO	.	.	+
SPO	.	.	+
THO (3)	.	.	+
PVO	.	.	—
MVO	.	.	—
SVO	.	.	—
IVO	.	.	+
AO	.	.	—
SAO	.	.	+
PAO	.	.	+
ICO	.	.	—
CO	.	.	+
PO	.	.	?
VO	.	.	—
OO.	.	.	2/2
		2/2	2/1

SAM 26143 represents the first record of the species in the south-western Indian Ocean.

Family **Gonostomatidae**

Valenciennellus tripunctulatus (Esmark, 1871)

Maurolicus tripunctulatus Esmark, 1871: 489.

Valenciennellus tripunctulatus: Goode & Bean, 1895: 513. Jordan & Evermann, 1896: 578. Murray & Hjort, 1912: 612, fig. 478. Pappenheim, 1914: 182. Norman, 1930: 300. Bruun, 1931: 290. Koefoed, 1958: 4. Grey, 1964: 219, fig. 59. Grindley & Penrith, 1965: 282.
(For full synonymy see Grey 1964: 224.)

Material

SAM 26209, 1 (21), St A 1894, 500–0 m.

SAM 26210, 3 (24–26), St A 3630, 1 000–0 m.

SAM 26211, 1 (24), St A 3634, 1 000–500–0 m.

Description

D 7; A 24; P 17; V 7; gill-rakers 3 + 12 (2 in angle). Branchiostegal rays 9–10. Eyes tubular, directed upward. Interorbital less than snout length. Photophores: ORB 1, in front of eye; OP 3–4, upper smaller, lower two level with end of maxillary; BR (6); IV (3) + (4) + (17) = 24; VAV 5, the first elevated and double; OA (2) + 3 = 5; AC (3) + (3) + (3) + (2) + (4) = 15. SAM 26211: AC (3) + (3) + (3) + (2) + (4) = 14 – 15.

Vinciguerria nimbaria (Jordan & Williams, 1895)*Zalarges nimbarius* Jordan & Williams, 1895: 793, pl. 76.*Vinciguerria nimbaria*: Norman, 1930: 292. Marshall, 1954: 342. Grey, 1955: 273; 1964: 130, figs 29–32.*Vinciguerria sanzoi* Jespersen & Tåning, 1919: 218, pl. 17, figs 2, 5; 1926: 22, figs 13–17. Norman, 1930: 292. Fraser-Brunner, 1931: 218. Fowler, 1936: 366, fig. 8, 1206. Smith, 1958: 131; 1961: 106, fig. 156. Grindley & Penrith, 1965: 282 (*partim*).
(For full synonymy see Grey 1964: 137.)*Material*

SAM 26212, 1 (19.5), St A 2386, 500–0 m.

Remarks

Distinguished from the related species, *V. attenuata*, by the presence of SO photophores and 18 gill-rakers on the first arch, of which 13 are on the lower limb. Grindley & Penrith (1965) referred all their *Vinciguerria* specimens to *V. sanzoi*, but one of these (SAM 23663) is identified as *V. nimbaria*. The others should be referred to *V. attenuata*.

Vinciguerria attenuata (Cocco, 1838)*Maurolicus attenuatus* Cocco, 1838: 193, pl. 8, fig. 13.*Vinciguerria attenuata* Jordon & Evermann, 1896: 577. Goode & Bean, 1895: 513. Norman, 1930: 291. Fowler, 1936: 1205. Marshall, 1951: 3; 1954: 109, figs 5, 14, xi, 8; 1960: 7, pl. 2, figs 1, 2. Grey, 1955: 273; 1964: 143, figs 29–31, 34.*Vinciguerria sanzoi*: Grindley & Penrith, 1965: 282 (*partim*).
(For full synonymy see Grey 1964: 148.)*Material*

SAM 26213, 1 (31), St A 1246, 500–0 m.

SAM 26214, 1 (24), St A 1877, 850–0 m.

SAM 26215, 1 (22), St A 2389, 820–0 m.

SAM 26216, 2 (13–15), St A 3616, 1 000–0 m.

SAM 26217, 2 (21–23), St A 3630, 1 000–0 m.

SAM 26218, 1 (24), St A 3632, 1 000–500–0 m.

SAM 26219, 1 (24), St A 3634, 1 000–500–0 m.

Remarks

Distinguished from *V. nimbaria* by the absence of SO photophores and from *V. poweriae* by a higher gill-raker count. In the above specimens, the gill-raker count of 19–22 is somewhat higher than the 18–19 range given by Grey (1964). Six specimens (SAM 23338, 23359, 23653) identified as *V. sanzoi* by Grindley & Penrith (1965) should be referred to *V. attenuata*.

Photichthys argenteus Hutton, 1873*Phosichthys argenteus* Hutton, 1873: 269 (*lapsus calami*).*Photichthys argenteus* Hutton, 1873: 269, pl. 15, fig. 90. Günther, 1887: 178, pl. 45, fig. A. Goode & Bean, 1895: 104, pl. 32, fig. 122. Brauer, 1906: 92, fig. 37. Gilchrist, 1922: 55. Barnard, 1925: 150. Norman, 1930: 292, pl. 2, figs 1, 2. Smith, 1961: 104, fig. 153. Grey, 1960: 100; 1964: 84. Grindley & Penrith, 1965: 282.

Material

- SAM 26220, 2 (19-21), St A 1894, 500-0 m.
 SAM 26221, 2 (59-64), St A 2968, 600-0 m.
 SAM 26222, 1 (235), St A 3616, 1 000-0 m.
 SAM 26223, 3 (98-241), St A 3630, 1 000-0 m.
 SAM 26224, 2 (15.5-16), St A 3632, 1 000-500-0 m.
 SAM 26225, 11 (108-160), St A 4229, 600-0 m.

Gonostoma atlanticum Norman, 1930

Gonostoma denudatum atlanticum Norman, 1930: 282. Marshall, 1960: 100, fig. 42A.
Gonostoma atlanticum: Grey, 1960: 105; 1961: 462; 1964: 166, fig. 38.
 (For full synonymy see Grey 1964: 171.)

Material

- SAM 26296, 2 (20-40), St A 2389, 820-0 m.

Remarks

Distinguished from the related *G. denudatum* by the lack of an adipose dorsal fin, presence of vomerine teeth, and a gill-raker count of 11 + 6 = 17.

These two specimens constitute the most southerly record of the species in the Atlantic.

Gonostoma elongatum Günther, 1878

Gonostoma elongatum Günther, 1878: 187; 1887: 173, pl. 45, fig. B. Brauer, 1906: 75, pl. 4, fig. 4, fig. 27. Murray & Hjort, 1912: 604, pl. 2, text fig. 490. Norman, 1930: 283. Fowler, 1936: 230, 1204, fig. 105. Marshall, 1951: 3; 1954: 209, pl. 4, figs vii, 12, ix, 4. Koefoed, 1958: 12. Grey, 1964: 171, figs 39, 40. Grindley & Penrith, 1965: 282.
 (For full synonymy see Grey 1964: 178.)

Material

- SAM 26297, 1 (157), St A 2961, 700-0 m.
 SAM 26298, 1 (142), St A 2968, 600-0 m.
 SAM 26299, 1 (190), St A 3616, 1 000-0 m.
 SAM 26300, 1 (169), St A 3643, 1 000-0 m.

Gonostoma bathyphilum (Vaillant, 1888)

Neostoma bathyphilum Vaillant, 1888: pl. 8, fig. 1.
Cyclothona bathyphilum: Gilchrist, 1913: 66. Fowler, 1936: 227, fig. 103.
Gonostoma grandis Barnard, 1925: 143.
Gonostoma bathyphilum: Norman, 1930: 285. Smith, 1961: 104, fig. 151. Grey, 1964: 180, figs 41, 42.
 (For full synonymy see Grey 1964: 183.)

Material

- SAM 26301, 2 (35-47), St A 3632, 1 000-500-0 m.

Cyclothona spp.*Material*

- SAM 26252, St A 1230, 250–0 m.
SAM 26253, St A 1234, 250–0 m.
SAM 26254, St A 1236, 250–0 m.
SAM 26255, St A 1237, 1 000–500–0 m.
SAM 26256, St A 1238, 1 000–500–0 m.
SAM 26257, St A 1239, 1 000–500–0 m.
SAM 26258, St A 1247, 1 500–0 m.
SAM 26259, St A 1250, 500–0 m.
SAM 26260, St A 1251, 500–0 m.
SAM 26261, St A 1252, 500–0 m.
SAM 26262, St A 1253, 500–0 m.
SAM 26263, St A 1254, 500–0 m.
SAM 26264, St A 1877, 820–0 m.
SAM 26265, St A 1879, 1 000–0 m.
SAM 26266, St A 1888, 1 000–0 m.
SAM 26267, St A 1892, 1 000–0 m.
SAM 26268, St A 1896, 1 000–0 m.
SAM 26269, St A 2386, 500–0 m.
SAM 26270, St A 2387, 823–0 m.
SAM 26271, St A 2389, 820–0 m.
SAM 26272, St A 2390, 823–0 m.
SAM 26273, St A 2391, 820–0 m.
SAM 26274, St A 2393, 820–0 m.
SAM 26275, St A 2394, 500–0 m.
SAM 26276, St A 2945, 700–0 m.
SAM 26277, St A 2951, 700–0 m.
SAM 26278, St A 2953, 600–0 m.
SAM 26279, St A 2958, 600–0 m.
SAM 26280, St A 2961, 700–0 m.
SAM 26281, St A 2963, 600–0 m.
SAM 26282, St A 2965, 600–0 m.
SAM 26283, St A 2966, 600–0 m.
SAM 26284, St A 2967, 600–0 m.
SAM 26285, St A 2968, 600–0 m.
SAM 26286, St A 3616, 1 000–0 m.
SAM 26287, St A 3630, 1 000–0 m.
SAM 26288, St A 3632, 1 000–500–0 m.
SAM 26289, St A 3634, 1 000–500–0 m.
SAM 26290, St A 3643, 1 000–0 m.
SAM 26291, St A 4218, 1 400–0 m.

Remarks

This genus was represented at almost every station (40 out of 48) and forms the bulk of the material collected. While Grindley & Penrith (1965) reported on the complete absence of *Cyclothona* specimens in their samples, several specimens have been found amongst their myctophid material (Wisner, personal communication).

Family **Sternopychidae***Argyropelecus gigas* Norman, 1930

Argyropelecus gigas Norman, 1930: 302, fig. 10. Fowler, 1936: 1208. Parr, 1937: 39. Schultz, 1938: 147; 1961: 600, fig. 5; 1964: 250, fig. 64. Blache, 1964a: 74, fig. Baird, 1971: 38, fig. 24.

Argyropelecus affinis: Jespersen, 1915: fig.

Material

SAM 26156, 1 (77), St A 2968, 600–0 m.

SAM 26157, 1 (38), St A 3634, 1 000–500–0 m.

SAM 26158, 4 (41–71), St A 4229, 600–0 m.

Argyropelecus aculeatus Cuvier & Valenciennes, 1849

Argyropelecus aculeatus Cuvier & Valenciennes, 1849: 406. Sauvage, 1891: 483, pl. 48, fig. 5. Goode & Bean, 1895: 127. Brauer, 1906: 110, fig. 47. Murray & Hjort, 1912: 642. Norman, 1930: 303, fig. 11. Schultz, 1961: 607, fig. 9; 1964: 256, fig. 62. Grindley & Penrith, 1965: 282. Baird, 1971: 48, fig. 35.

Argyropelecus acanthurus Fowler, 1936: 246, 1207.

(For full synonymy see Schultz 1961: 607.)

Material

SAM 26159, 1 (27), St A 1230, 250–0 m.

SAM 26160, 1 (10), St A 2387, 823–0 m.

SAM 26161, 1 (12), St A 2966, 600–0 m.

SAM 26162, 1 (23), St A 3630, 1 000–0 m.

Argyropelecus hemigymnus Cocco, 1829

Argyropelecus hemigymnus Cocco, 1829: 146. Brauer, 1906: 106, fig. 45. Zugmayer, 1911b: 51. Murray & Hjort, 1912: 612. Gilchrist, 1913: 66. Pappenheim, 1914: 182. Barnard, 1925: 153. Norman, 1930: 303, pl. 2, fig. 4. Schultz, 1937: 4; 1961: 601, fig. 6; 1964: 251, fig. 65. Smith, 1961: 107, fig. 160. Blache, 1964a: 76. Grindley & Penrith, 1965: 282. Baird, 1971: 42, fig. 28.

(For full synonymy see Schultz 1961: 601.)

Material

SAM 26175, 1 (12), St A 1239, 1 000–500–0 m.

SAM 26176, 10 (9–15), St A 1246, 500–0 m.

SAM 26177, 1 (21), St A 1250, 500–0 m.

SAM 26178, 2 (damaged), St A 1253, 500–0 m.

SAM 26179, 2 (9–42), St A 1254, 500–0 m.

- SAM 26180, 3 (11–19), St A 1892, 1 000–0 m.
 SAM 26181, 8 (8–33), St A 1894, 500–0 m.
 SAM 26182, 3 (10–11), St A 1896, 1 000–0 m.
 SAM 26183, 1 (22), St A 2389, 820–0 m.
 SAM 26184, 1 (damaged), St A 2390, 823–0 m.
 SAM 26185, 3 (13–25), St A 2945, 700–0 m.
 SAM 26186, 1 (31), St A 2958, 600–0 m.
 SAM 26187, 1 (14), St A 2965, 600–0 m.
 SAM 26188, 5 (10–25), St A 2966, 600–0 m.
 SAM 26189, 3 (30–33), St A 2968, 600–0 m.
 SAM 26190, 1 (25), St A 3616, 1 000–0 m.
 SAM 26191, 10 (16–27), St A 3630, 1 000–0 m.
 SAM 26192, 1 (17), St A 3632, 1 000–500–0 m.
 SAM 26193, 7 (17–27), St A 3634, 1 000–500–0 m.
 SAM 26194, 1 (21), St A 4229, 600–0 m.

Remarks

Schultz (1961) distinguished two species in the *hemigymnus*-complex: *A. hemigymnus*, which he confined to the Mediterranean and Atlantic, and is replaced by *A. intermedius* in the Indo-Pacific region. Although he did not examine specimens from the Cape of Good Hope, Schultz (1961) placed *A. hemigymnus* recorded off South Africa by Barnard (1925) and Smith (1961) in the synonymy of *A. intermedius*, referred Norman's (1930) specimens from similar localities to *A. hemigymnus*, and placed the single specimen recorded by Gilchrist (1913) under both synonymies. Blache (1964a) suggests that *A. hemigymnus* and *A. intermedius* may only be geographical subspecies, and he restricts *A. hemigymnus* to localities north of the equator and *A. intermedius* to localities south of about 11°S. Grindley & Penrith (1965) refer all their specimens to *A. hemigymnus*.

Examination of some 60 specimens from both the eastern South Atlantic and western South Indian Ocean has revealed that the diagnostic characters for separating the two species used by Schultz (1961) are extremely variable: specimens were found to have a barbed dorsal blade and smooth pectoral shield (i.e. *A. hemigymnus*); smooth dorsal blade and scalloped pectoral shield (i.e. *A. intermedius*); and specimens with combinations of the two characters. It is therefore probable that there is a single species, and all specimens have consequently been referred to *A. hemigymnus*. Baird (1971) has included *A. intermedius* as a junior synonym of *A. hemigymnus*.

Sternopyx diaphana Hermann, 1781

Sternopyx diaphana Hermann, 1781: 33. Cuvier & Valenciennes, 1849: 415. Günther, 1887: 169, pl. 45, figs D, D¹. Goode & Bean, 1895: 124, pl. 39, fig. 146. Brauer, 1906: 115, figs 56–63. Pappenheim, 1914: 183. Barnard, 1925: 154. Norman, 1930: 305. Fowler, 1936: 241, 1207, fig. 113. Smith, 1961: 106. Schultz, 1961: 617, fig. 2; 1964: 262, fig. 69. Blache, 1964a: 83, fig. Baird, 1971: 75, fig. 58.
 (For full synonymy see Schultz 1961: 617.)

Material

- SAM 26163, 1 (damaged), St A 1254, 500–0 m.
 SAM 26164, 2 (29–34), St A 2945, 700–0 m.
 SAM 26165, 2 (22–25), St A 2948, 700–0 m.
 SAM 26166, 1 (40), St A 2958, 600–0 m.
 SAM 26167, 1 (15), St A 2965, 600–0 m.
 SAM 26168, 1 (18), St A 2966, 600–0 m.
 SAM 26169, 2 (14–16), St A 2967, 600–0 m.
 SAM 26170, 1 (17), St A 2968, 600–0 m.
 SAM 26171, 6 (13–16), St A 3616, 1 000–0 m.
 SAM 26172, 1 (13), St A 3630, 1 000–0 m.
 SAM 26173, 2 (11–15), St A 3632, 1 000–500–0 m.
 SAM 26174, 1 (32), St A 3643, 1 000–0 m.

Family **Stomiatidae***Stomias boa boa* (Risso, 1810)

Esox boa Risso, 1810: 330, pl. 10, fig. 34.

Stomias boa: Cuvier, 1817: 184. Risso, 1826: 440, pl. 14, fig. 40. Goode & Bean, 1895: 108, pl. 35, fig. 128. Brauer, 1906: 49. Zugmayer, 1911b: 71, pl. 4, fig. 1. Barnard, 1925: 137. Smith, 1961: 98, fig. 131. Gibbs, 1969: 4, fig. 5.

Stomias boa boa Morrow, 1964a: 293.

Material

- SAM 24640, 1 (102), St A 3630, 1 000–0 m.
 SAM 24641, 1 (210), St A 1888, 1 000–0 m.
 SAM 24642, 1 (252), St A 1888, 1 000–0 m.
 SAM 24657, 1 (162), St A 2963, 600–0 m.
 SAM 26292, 1 (75), St A 3634, 1 000–500–0 m.

Family **Chauliodontidae***Chauliodus sloani* Bloch & Schneider, 1801

Chauliodus sloani Bloch & Schneider, 1801: 430. Cuvier & Valenciennes, 1849: 382. Goode & Bean, 1895: 96, fig. 115. Gilchrist, 1913: 66; 1922: 42. Fowler, 1936: 219. Smith, 1961: 102, fig. 145. Morrow, 1964c: 283, fig. 74. Grindley & Penrith, 1965: 282. Gibbs & Hurwitz, 1967: 798, figs 1–3.

Chauliodus sloanii Günther, 1887: 179.

Chauliodus sloanei: Brauer, 1906: 40, figs 7–9. Pappenheim, 1914: 167. Barnard, 1925: 141. Regan & Trewavas, 1929: 32, fig. 24. Norman, 1930: 308; 1939: 21.
 (For full synonymy see Morrow 1964c: 287.)

Material

- SAM 24498, 1 (damaged), St A 1239, 1 000–500–0 m.
 SAM 26195, 3 (55–58), St A 2945, 700–0 m.
 SAM 26196, 1 (229), St A 2948, 700–0 m.
 SAM 26197, 1 (245), St A 2961, 700–0 m.
 SAM 26198, 3 (41–204), St A 2966, 600–0 m.
 SAM 26199, 1 (30), St A 2967, 600–0 m.
 SAM 26200, 6 (125–246), St A 2968, 600–0 m.

- SAM 26201, 1 (194), St A 3616, 1 000–0 m.
 SAM 26202, 4 (35–124), St A 3630, 1 000–0 m.
 SAM 26203, 2 (113–119), St A 3634, 1 000–500–0 m.
 SAM 26204, 1 (195), St A 3643, 1 000–0 m.
 SAM 26205, 2 (109–150), St A 4229, 600–0 m.
 SAM 26206, 1 (59), St A 3632, 1 000–500–0 m.

Family **Astronesthidae**

Astronesthes indicus Brauer, 1902

Astronesthes indicus Brauer, 1902: 287; 1906: 33, fig. 5, pl. 2, fig. 3. Regan & Trewavas, 1929: 23.
 Norman, 1930: 306. Gibbs, 1964: 322, fig. 82.
 (For full synonymy see Gibbs 1964: 323.)

Material

- SAM 24654, 1 (31,0), St A 2966, 600–0 m.

Description

D 16; A 15; P 6; V 6. OV 5; VAL 8; IP 5; PV 6; VAV 8; AC 8.

Remarks

This represents the first record of the species in the eastern South Atlantic.

Neonesthes capensis (Gilchrist & Von Bonde, 1924)

Astronesthes capensis Gilchrist & Von Bonde, 1924: 5. Barnard, 1925: 134. Smith, 1961: 101.

Neonesthes capensis: Gibbs, 1964: 346, fig. 91.

Neonesthes macrolychnus Regan & Trewavas, 1929: 30. Norman, 1930: 308.

(For full synonymy see Gibbs 1964: 348.)

Material

- SAM 24636, 1 (152,4), St A 3616, 1 000–0 m.
 SAM 24646, 1 (140,0), St A 3632, 1 000–500–0 m.
 SAM 24650, 1 (151,5), St A 2957, 700–0 m.

Description

D 10(9); A 25 (24); P 8 (7); V 7.

Family **Melanostomiatidae**

Echiostoma barbatum Lowe, 1843

Echiostoma barbatum Lowe, 1843: 88. Smith, 1961: 99, fig. 135. Morrow & Gibbs, 1964: 482,
 fig. 135.

Echiostoma tanneri: Norman, 1930: 314. Barnard, 1937: 48.

(For full synonymy see Morrow & Gibbs 1964: 486).

Material

- SAM 23293, 1 (28,0), St A 1896, 1 000–0 m.

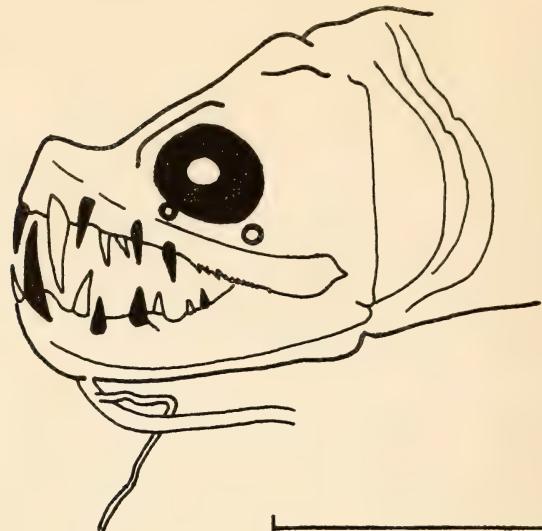
Remarks

This specimen represents the first record of the species in the Indian Ocean.

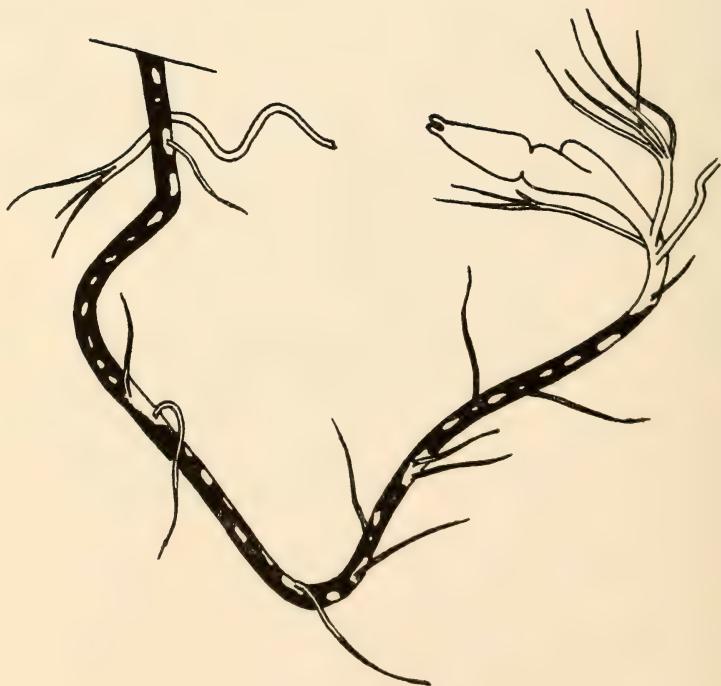
Leptostomias gladiator (Zugmayer, 1911)

Nematostomias gladiator Zugmayer, 1911a: 5; 1911b: 76, pl. 3, fig. 5.

Leptostomias gladiator Regan & Trewavas, 1930: 61, fig. 41B. Morrow & Gibbs, 1964: 441, fig. 131
 A, G–K.



[Scale bar]



[Scale bar]

FIG. 3 *Leptostomias gladiator* (Zugmayer, 1911); head and barbel. Fixed teeth black, depressible teeth unshaded.

Material

SAM 26294, 1 (95), St A 1246, 500–0 m.

Description

D 20; A 25; P 9; V 7. IP 11; PV 42; VAV 17 + 4; OV 40; VAL 17; AC 17; suborbital 1; postorbital absent.

Remarks

The specimen falls closest to *L. gladiator*, in having a filament at the base of the stem of the barbel, one pair of strongly developed filaments at the base of the bulb, and two tubercles at the distal end of the bulb. The form of the bulb (Fig. 3) differs from those figured by Morrow & Gibbs (1964: fig. 131, G–K), but this feature appears to be highly variable in different specimens.

This specimen represents the first record of the species in the Indian Ocean.

Eustomias sp.*Material*

SAM 26295, 1 (\pm 73), St A 1254, 500–0 m.

Remarks

The specimen is damaged and the barbel is missing. One species, *Eustomias filiferum*, is at present known from southern African waters (Smith 1961).

Opostomias gibsonpacei Barnard, 1948

Opostomias gibsonpacei Barnard, 1948: 344, figs 1, 2. Smith, 1961: 100.

Material

SAM 24649, 1 (264), St A 2957, 700–0 m.

Description

D 23; A 25; P 1 + 5; V 9. First mandibular tooth piercing premaxillary. Suborbital 1; postorbital 1; IP 10; PV 28; VAV 24; OV 26; VAL 21; AC 18.

Remarks

Gibbs (personal communication) considers that *O. gibsonpacei* may be a junior synonym of *O. micripnus*.

Flagellostomias boureei (Zugmayer, 1913)

Eustomias boureei Zugmayer, 1913: 3.

Flagellostomias boureei Regan & Trewavas, 1930: 57, figs 8 D, 9 B, 11 A, 12 A, 33, 34, pl. 2, fig. 2.

Norman, 1930: 310. Morrow & Gibbs, 1964: 430, fig. 130.

(For full synonymy see Morrow & Gibbs 1964: 433.)

Material

SAM 24639, 1 (223), St A 3616, 1 000–0 m.

Description

D 15; A 25; P 1 + 8; V 7.

Bathophilus ater (Brauer, 1902)

Dactylostomias ater Brauer, 1902: 286; 1906: 57, pl. 3, fig. 3.

Bathophilus ater Regan & Trewavas, 1930: 68, fig. 46. Morrow & Gibbs, 1964: 461. Barnett & Gibbs, 1968: 831.

Material

SAM 24656, 1 (90,0), St A 2962, 600–0 m.

Description

D 16; A 15; P 6 (the first two rays longer and a little separated); V 10. Postorbital photophore with luminous patches in front and below.

Remarks

While dorsal and anal counts are somewhat higher, and pectoral and pelvic counts somewhat lower, than the values given by Regan & Trewavas (1930), the specimen falls closest to *B. ater* in arrangement of the pectoral fin rays, the presence of two luminous patches associated with the postorbital photophore, and an IA count of 38.

Pachystomias microdon (Günther, 1878)

Eustomias microdon Günther, 1878: 180.

Pachystomias microdon Günther, 1887: 210, pl. 53, fig. C. Regan & Trewavas, 1930: 70, figs 14 B, 15. Morrow & Gibbs, 1964: 375, fig. 97.

Pachystomias atlanticus Regan & Trewavas, 1930: 70, pl. 6, fig. 1.

(For full synonymy see Morrow & Gibbs 1964: 377.)

Material

SAM 246, 35, 1 (183,9), St A 3616, 1 000–0 m.

Remarks

The specimen has been identified by Mr R. H. Goodyear.

Family **Malacosteidae***Malacosteus niger* Ayres, 1848

Malacosteus niger Ayres, 1848: 69; 1849: 53, pl. 5. Günther, 1887: 214, pl. 54, fig. C. Murray & Hjort, 1912: 612. Regan & Trewavas, 1930: 142, figs 25, 138. Norman, 1930: 317. Koefoed, 1956: 16. Morrow, 1964b: 545, fig. 144.

Malacosteus indicus Günther, 1878: 181; 1887: 214, pl. 54, fig. B. Brauer, 1906: 65, figs 23–25, pl. 4, fig. 1. Gilchrist, 1922: 54. Barnard, 1925: 139. Regan & Trewavas, 1930: 143. Smith, 1961: 100, fig. 137.

(For full synonymy see Morrow 1964b: 547.)

Material

- SAM 24644, I (110), St A 3634, I 000–500–0 m.
 SAM 24645, I (112,5), St A 3634, I 000–500–0 m.
 SAM 24651, I (72,4), St A 2966, 600–0 m.
 SAM 24652, I (84,4), St A 2966, 600–0 m.
 SAM 24653, I (75,7), St A 2966, 600–0 m.
 SAM 24655, I (94,5), St A 2962, 600–0 m.
 SAM 24659, I (149,0), St A 2948, 700–0 m.
 SAM 24660, I (159,0), St A 2967, 600–0 m.
 SAM 26226, I (152,0), St A 2393, 820–0 m.
 SAM 26227, I (24,0), St A 3630, I 000–0 m.

Remarks

Two species have been distinguished by Morrow (1964b) on the basis of the size of the postorbital photophore. However, in the above specimens, the size of this photophore appears to vary with age and ranges from 24,0% (SAM 24655) to 31,8% (SAM 24660) of the eye diameter. It is probable therefore that *M. danae* is a junior synonym of *M. niger*.

Family **Idiacanthidae***Idiacanthus fasciola* Peters, 1877

- Idiacanthus fasciola* Peters, 1877: 847. Günther, 1887: 215. Brauer, 1906: 60, figs 17–20, 22, pl. 4, figs 2–3. Pappenheim, 1914: 168. Regan & Trewavas, 1930: 129. Fowler, 1936: 1199. Koefoed, 1956: 8. Smith, 1961: 102. Gibbs, 1964: 514, figs 137–140. Grindley & Penrith, 1965: 282.
Idiacanthus ferox Günther, 1887: 216, pl. 52, fig. D. Brauer, 1906: 59. Murray & Hjort, 1912: 86. Barnard, 1925: 136.
 (For full synonymy see Gibbs 1964: 520.)

Material

- SAM 24658, I (85), St A 2953, 600–0 m.
 SAM 26239, I (61), St A 2968, 600–0 m.

Idiacanthus atlanticus Brauer, 1906

- Idiacanthus atlanticus* Brauer, 1906: 62, fig 21, Smith, 1961: 102. Krueger, 1967. Novikova 1967,
Idiacanthus niger Regan, 1914: 14; 1916a: 378. Regan & Trewavas, 1930: 128, fig 124. Smith, 1961: 102 fig. 142. Grindley & Penrith, 1965: 282.

Material

- SAM 24637, I (345), St A 3616, I 000–0 m.
 SAM 24638, I (375), St A 3616, I 000–0 m.
 SAM 24643, I (314), St A 3634, I 000–0 m.
 SAM 24644, I (43), St A 3630, I 000–0 m.
 SAM 24661, I (423), St A 2967, 600–0 m.
 SAM 26240, I (415), St A 2391, 820–0 m.
 SAM 26241, I (423), St A 4218, I 400–0 m.
 SAM 26243, 2 (42–44) St A 3613, I 000–0 m.

Remarks

Distinguished from the related species *I. fasciola* by the anterior position of the pelvic fins and by 16 photophores situated between the pelvic and anal origins. SAM 24661 with pelvic origin just in front of dorsal origin. Juvenile males with long intromittent organ incorporating anterior anal rays.

Idiacanthus sp.

Stylophthalmus paradoxus Brauer, 1906: 67, pl. 5, figs 1-7. Regan, 1916b: 136. Barnard, 1925: 140. Smith, 1961: 100, fig. 138.

Material

SAM 26242, 3 (no SL), St A 1234, 250-0 m.

Remarks

Although described as a separate species by Brauer (1906), specimens of this type are now known to be larval stages of *Idiacanthus* (Beebe 1934; Gibbs 1964).

Family **Bathylagidae***Bathylagus antarcticus* Günther, 1878

Bathylagus antarcticus Günther, 1878: 248; 1887: 220. Goode & Bean, 1895: 55. Brauer, 1906: 12, fig. 2. Barnard, 1925: 129. Norman, 1930: 276; 1937: 81. Smith, 1961: 97, fig. 130.

Bathylagus glacialis Lönningberg, 1905b: 68. Norman, 1930: 276. Blache, 1964b: 11, fig.

Material

SAM 26245, 2 (48-60), St A 1888, 1 000-0 m.

SAM 26246, 1 (37), St A 2953, 600-0 m.

SAM 26248, 1 (27), St A 4218, 1 400-0 m.

Remarks

Norman (1930) distinguished between *B. antarcticus* and *B. glacialis* mainly on the basis of anal fin ray count: 18-21 in *B. glacialis*; (21) 22-25 in *B. antarcticus*. This has been followed by Blache (1964b). However, Barnard (1925) and Smith (1961) hold that the two species are synonymous. There is a definite overlap of anal ray counts in the above specimens and therefore all material has been referred to *B. antarcticus*. SAM 26245 represents the first record of the species in the Indian Ocean.

Bathylagus bericoides (Borodin, 1929)

Scopelus bericoides Borodin, 1929: 110.

Bathylagus microcephalus Norman, 1930: 275, fig. 5. Grindley & Penrith, 1965: 282.

Bathylagus bericoides Parr, 1937: 39, fig. 16. Cohen, 1964: 46, fig. 15.

Material

SAM 26247, 4 (51-61), St A 3616, 1 000-0 m.

SAM 26249, 1 (212), St A 2961, 700-0 m.

SAM 26250, 1 (189), St A 2963, 600-0 m.

SAM 26251, 1 (114), St A 3616, 1 000-0 m.

Family Scopelarchidae

Neoscopelarchoides elongatus (Norman, 1937)

Scopelarchus elongatus Norman, 1937: 86.

Neoscopelarchoides elongatus: Marshall, 1955: 310, fig. 3b, b¹, pl. 19, figs 1, 2.

Material

SAM 26228, 1 (106), St A 2953, 600–0 m.

Remarks

This specimen represents the first record of the species in South African waters, and completes the circumpolar distribution pattern of the species given by Marshall (1955: fig. 4).

Family Scopelosauridae

Scopelosaurus sp.

Material

SAM 23605, 1 (damaged), St A 2966, 600–0 m.

SAM 23606, 1 (37.5), St A 2945, 700–0 m.

SAM 23607, 1 (31.5), St A 2963, 600–0 m.

Remarks

The specimens have been sent to Bertelsen, Krefft and Marshall, and are to be described in a revision of the family by these authors.

Family Myctophidae

Protomyctophum (*Protomyctophum*) *anderssoni* (Lönnberg, 1905)

Myctophum anderssoni Lönnberg, 1905a: 763; 1905b: 61. Norman, 1930: 320.

Myctophum (*Myctophum*) *anderssoni* Brauer, 1906: 172, fig. 84.

Electrona (*Protomyctophum*) *anderssoni* Fraser-Brunner, 1949: 1046, fig.

Protomyctophum (*Protomyctophum*) *anderssoni* Andriashev, 1963: 226, figs 6, 7. Becker, 1963: 2 (transl.); 1967: 89.

(For full synonymy see Andriashev 1962: 226.)

Material

SAM 26073, 2 (26.9–27.0), St A 1888, 1 000–0 m.

Description

P 14; V 8; gill-rakers 7 + 1 + 19 (20); SAO 2.

Remarks

Both specimens are damaged, so that dorsal, anal and AO counts are not possible.

Protomyctophum (*Protomyctophum*) *normani* (Tåning, 1932)

Myctophum normani Tåning, 1932: 127, fig. 2.

Electrona (*Protomyctophum*) *normani* Fraser-Brunner, 1949: 1046, fig.

Protomyctophum (*Protomyctophum*) *normani* Andriashev, 1962: 231, fig. 10. Becker, 1963: 4 (transl.) fig. 1; 1967: 89.

Material

SAM 26074, 3 (14.8-18.0), St A 2393, 820-0 m.

Description

D 13; A 23 (22); P 14; V 8; gill-rakers 6 + 1 + 19; AO 15-17.

Remarks

Although resembling *P. tenisoni* in that the Prc_1 and Prc_2 are almost touching, the specimens have been identified as *P. normani* because of the number of AO photophores and the position of SAO_1 above VO_3 . It appears that Andriashev's (1962) key character regarding the origin of the anal fin in relation to the dorsal may be open to question. In these specimens, the origin of the anal fin is below the middle of the dorsal fin. The pectoral count, furthermore, appears to be somewhat higher than that of Andriashev's two specimens.

Protomyctophum (Protomyctophum) bolini (Fraser-Brunner, 1949)

Electrona (Protomyctophum) bolini Fraser-Brunner, 1949: 1045, fig.

Protomyctophum (Protomyctophum) bolini Andriashev, 1962: 232, figs 11, 12. Becker, 1963: 3 (transl.); 1967: 90.

Material

SAM 26075, 3 (15.9-16.2), St A 1879, 1 000-0 m.

SAM 26076, 11 (15.5-18.0), St A 2393, 820-0 m.

SAM 26077, 2 (14.0-17.2), St A 2394, 820-0 m.

SAM 26078, 1 (15.0), St A 2958, 600-0 m.

Description

D 12 (13); A 24 (23); P 15; V 8; gill-rakers 5 + 1 + 15 (16); AO 17 (18).

Protomyctophum (Protomyctophum) ? andriashevi Becker, 1963

Protomyctophum (Protomyctophum) andriashevi Becker, 1963: 6 (transl.), fig. 2; 1967: 89.

Material

SAM 26079, 1 (47.3), St A 4218, 1 400-0 m.

Description

D 13; A 24; P 16; V 8; gill-rakers 4 + 1 + 14; AO 16.

Remarks

Four species of primitive Myctophinae are known in which the distance between Prc_1 and Prc_2 is less than an organ diameter, namely *P. andriashevi*, *P. normani*, *P. anderssoni* and *P. tenisoni*. This specimen has 3 SAO photophores and can be distinguished from *P. anderssoni*, and has tentatively been identified as *P. andriashevi* according to Becker's (1963) table for the separation of the

other named species. In this specimen, the pectoral count, AO count, gill-raker count and the position of SAO₁ correspond to that of *P. andriashevi* rather than *P. normani* or *P. tenisoni*, but the line SAO₁/SAO₃ passes through VO₁ rather than VO₂.

Protomyctophum (Hierops) parallelum (Lönnberg, 1905)

Myctophum parallelum Lönnberg, 1905a: 764.

Myctophum (Myctophum) parallelum Brauer, 1906: 174, fig. 86.

Electrona (Hierops) parallela Fraser-Brunner, 1949: 1047, fig.

Protomyctophum (Hierops) parallelum Andriashev, 1962: 237, fig. 16. Becker, 1963: 9 (*transl.*); 1967: 90. Nafpaktitis & Nafpaktitis, 1969: 8, figs 3, 4.

Material

SAM 26080, 1 (27,7), St A 2961, 700–0 m.

SAM 26081, 1 (41,0), St A 2963, 600–0 m.

Description

D 12; A 23–24; P 14; V 8; gill-rakers 3 + 1 + 13; AO 17–19.

Remarks

Both specimens have AO counts varying on the two sides: SAM 26080, AO 17–18; SAM 26081, AO 18–19.

Protomyctophum (Hierops) subparallelum (Tåning, 1932)

Myctophum arcticum subparallelum Tåning, 1932: 128.

Electrona (Hierops) arctica subparallelala Fraser-Brunner, 1949: 1047.

Hierops subparallelala Bolin, 1959: 5.

Protomyctophum (Hierops) subparallelum Andriashev, 1962: 243, figs 14, 15. Nafpaktitis & Nafpaktitis, 1969: 8, figs 4–6.

(For full synonymy see Andriashev 1962: 243.)

Material

SAM 26082, 1 (24,2), St A 2394, 820–0 m.

Description

D 12; A 22; P 15; V 8; gill-rakers 4 + 1 + 13; AO 15.

Electrona antarctica (Günther, 1878)

Scopelus antarcticus Günther, 1878: 184; 1887: 196, pl. 51, fig. D.

Myctophum antarcticum Norman, 1930: 322, fig. 28; 1937: 85. Smith, 1961: 120.

Myctophum (Myctophum) antarcticum Brauer, 1906: 168, fig. 82 a–c.

Electrona (Electrona) antarctica Fraser-Brunner, 1949: 1048, fig.

Electrona antarctica: Andriashev, 1962: 240, figs 18, 19.

(For full synonymy see Andriashev 1962: 240.)

Material

SAM 26083, 2 (22,2–23,3), St A 1888, 1 000–0 m.

Description

D 13; A 21; P-; V 8; gill-rakers 4 + 1 + 13; AO 18.

Remarks

The low gill-raker count, position and size of the PLO and the number of AO photophores, which occur in an even line, separate this species from the related *E. carlsbergi*, *E. subaspera*, *E. paucirastra* and *E. ventralis*.

SAM 26083 represents the most northern record of the species in the Indian Ocean ($43^{\circ}17'S$, $48^{\circ}55'E$).

Electrona rissoii (Cocco, 1829)

Scopelus rissoii Cocco, 1829: 144; 1838: 15, pl. 2, fig. 5.

Myctophum rissoii: Brauer, 1906: 170, fig. 83. Fowler, 1936: 380, fig. 184. Norman, 1930: 320.

Electrona (Electrona) rissoii Fraser-Brunner, 1949: 1048, fig.

Electrona rissoii Bolin, 1959: 5. Becker, 1967: 92. Trunov, 1968: 745, fig. 1. Nafpaktitis & Nafpaktitis, 1969: 10, figs 4, 6, 8.

(For full synonymy see Bolin 1959: 5.)

Material

SAM 26084, 2 (52.5-53.0), St A 4229, 600-0 m.

Description

D 13; A 19; P 15; V 8; gill-rakers 8 + 1 + 19; AO 11.

Benthosema suborbitale (Gilbert, 1913)*Material*

Myctophum suborbitale Gilbert, 1913: 82.

Myctophum (Benthosema) suborbitale Bolin, 1939: fig. 3.

Benthosema suborbitale Fraser-Brunner, 1949: 1051, fig. Bolin, 1959: 10. Becker, 1967: 95. Nafpaktitis & Nafpaktitis, 1969: 11, figs 9, 10.

SAM 26085, 2 (21.0-27.0), St A 1253, 500-0 m.

SAM 26086, 1 (24.5), St A 2966, 600-0 m.

Description

D 13 (12); A 17; P 14; V 8; gill-rakers 3 + 1 + 9 (10); AO 5 + 6.

Remarks

Distinguished from *B. fibulatum*, also known from the Indian Ocean ($4^{\circ}N$ - $18^{\circ}N$), by gill-raker count and by the presence of a luminous organ on the ventral border of the orbit. Grindley & Penrith (1965) report the occurrence of *B. fibulatum* off the Natal coast, but on the basis of distribution, it seems likely that these specimens should be referred to *B. suborbitale*.

Diogenichthys atlanticus (Tåning, 1928)

Myctophum laternatum atlanticum Tåning, 1928: 56.

Myctophum laternatum Norman, 1930: 324.

Diogenichthys scofieldi Bolin, 1939: 22 figs 3, 16.

Diogenichthys atlanticus Fraser-Brunner, 1949: 1054, fig. Bolin, 1959: 11. Becker, 1967: 95. Nafpaktitis & Nafpaktitis, 1969: 13, figs 12, 13.

Material

- SAM 26087, 1 (21,0), St A 1239, 1 000–500–0 m.
 SAM 26088, 3 (11,5–17,5), St A 1254, 500–0 m.
 SAM 26089, 1 (13,5), St A 1894, 500–0 m.
 SAM 26090, 1 (20,0), St A 2966, 600–0 m.
 SAM 26091, 1 (17,0), St A 3630, 1 000–0 m.
 SAM 26092, 1 (16,0), St A 4229, 600–0 m.

Description

D 11; A 16 (17); P 13 (12); V 8; gill-rakers 2 (3) + 1 + 12 (11); AO 7 + 3 (4).

Hygophum proximum Becker, 1965

Hygophum proximum Becker, 1965: 81, fig. 7 a. Nafpaktitis & Nafpaktitis, 1969: 17, figs 16, 17.
 (For full synonymy see Becker 1965: 81.)

Material

- SAM 26093, 1 (17,3), St A 1230, 250–0 m.

Description

D 13; A 18; P 13; V 8; gill-rakers 4 + 1 + 13; AO 5 + 6.

Remarks

Both Becker (1965) and Nafpaktitis & Nafpaktitis (1969) suggest that the distinctive characters of *H. proximum* may only be of subspecific importance and that the species probably consists of a series of geographically varying populations of *H. microchir*. SAM 26093 has tentatively been identified as *H. proximum* because of the position of Pol₁ and because the line connecting Pol₂ with Pol₁ passes through the anterior margin of the last AO_a. The number of AO photophores (5 + 6) is somewhat lower than the values (7 + 7; 6 + 7) found in southern specimens (Nafpaktitis & Nafpaktitis 1969).

Hygophum hygomi (Lütken, 1892)

Scopelus hygomi Lütken, 1892: 256 (*partim*), fig. 15.

Hygophum hygomi Fraser-Brunner, 1949: 1050, fig. Bolin, 1959: 6. Grindley & Penrith, 1965: 282.
 Becker, 1965: 68, fig. 3; 1967: 92. Nafpaktitis & Nafpaktitis, 1969: 19, figs 17, 18.
 (For full synonymy see Becker 1965: 68.)

Material

- SAM 26094, 1 (16,7), St A 1251, 500–0 m.
 SAM 26095, 1 (18,5), St A 1252, 500–0 m.
 SAM 26096, 4 (13,0–14,5), St A 1254, 500–0 m.
 SAM 26097, 6 (13,4–21,0), St A 1894, 500–0 m.
 SAM 26098, 4 (14,0–15,0), St A 1896, 1 000–0 m.

Description

D 14; A 21; P 15; V 8; gill-rakers 5 + 1 + 15 (14); AO 7 + 6 (5).

Hygophum hansenii (Tåning, 1932)

Scopelus hygomi Lütken, 1892: 256 (partim).

Myctophum (Myctophum) benoiti var. *reinhardti* Barnard, 1925: 242.

Myctophum hansenii Tåning, 1932: 132, fig. 4.

? *Myctophum reinhardti*: Smith, 1961: 121.

Hygophum hansenii Fraser-Brunner, 1949: 1050, fig. Bolin, 1959: 7. Becker, 1965: 95, fig. 11 a; 1967: 94. Nafpaktitis & Nafpaktitis, 1969: 19, figs 17, 18.

Material

SAM 26099, 1 (28,2), St A 2391, 820–0 m.

Description

D 13; A 21; P 15; V 8; gill-rakers 4 + 1 + 12; AO 5 + 8.

Symbolophorus boops (Richardson, 1844)

Myctophum boops Richardson, 1844: 39, pl. 27, figs 6–12.

Myctophum humboldti (non Risso) Norman, 1930: 325. Smith, 1961: 120, fig. 195.

Myctophum humboldti barnardi Tåning, 1932: 128.

Symbolophorus boops: Andriashev, 1962: 252, figs 24, 25. Becker, 1967: 96. Nafpaktitis & Nafpaktitis, 1969: 27, figs 29, 30.

(For full synonymy see Andriashev 1962: 252.)

Material

SAM 26100, 2 (19,2–22,8), St A 4229, 600–0 m.

Description

D 14; A 20–22; P 12; V 8; gill-rakers 5 + 1 + 12–13; AO 7 + 7–8.

Remarks

Confusion appears to exist in the identification of *S. boops* and *S. veranyi* from southern African waters. Bolin (1959) has referred specimens from the Cape of Good Hope to *S. veranyi*, while Andriashev (1962) refers specimens from this region to *S. boops*. Becker (1965) records both species from the South Atlantic. Until the situation becomes clearer, SAM 26100 is referred to *S. boops*.

Notolynchus valdiviae (Brauer, 1904)

Myctophum valdiviae Brauer, 1904: 398, fig. 6. Fowler, 1936: 375, fig. 182.

Myctophum (Myctophum) valdiviae Brauer, 1906: 206, fig. 127.

Vestula valdiviae Bolin, 1946: 146, fig. 4.

Notolynchus valdiviae Fraser-Brunner, 1949: 1077, fig. Bolin, 1959: 23. Becker, 1967: 108. Nafpaktitis & Nafpaktitis, 1969: 33, figs 37, 38.

Material

SAM 26101, 2 (13,0–17,0), St A 1234, 250–0 m.

SAM 26102, 1 (16,0), St A 1236, 250–0 m.

SAM 26103, 1 (20,1), St A 2966, 600–0 m.

Description

D 11; A 13 (12); P 11-12; V 6; gill-rakers 2 + 1 + 7 (8).

Remarks

AO counts were not possible as the specimens had been badly rubbed. The absence of records from the eastern South Atlantic would confirm the distribution pattern of the species. SAM 26103 represents the southernmost record for the species in the Indian Ocean.

Lampadena notialis Nafpaktitis & Paxton, 1968

Lampadena notialis Nafpaktitis & Paxton, 1968: 13, fig. 5. Nafpaktitis & Nafpaktitis, 1969: 34, figs 40, 43.

Material

SAM 26104, 2 (20.2-28.0) St A 2391, 820-0 m.

Description

D 14; A 14; P 14; V 8; gill-rakers 7 + 1 + 16-17; AO 6 + 3; Prc 2 + 1.

Remarks

Although closely resembling *L. speculigera*, with which it overlaps in the region 40°-45°S in the southern Indian Ocean, these specimens have a gill-raker count 24-25, which is typical of *L. notialis*. This record therefore represents the first in the southern African region. One specimen with AO_a5 (all level) on the one side.

Lampanyctus alatus Goode & Bean, 1895

Lampanyctus alatus Goode & Bean, 1895: 79 (*partim*). Norman, 1930: 330. Grindley & Penrith, 1965: 283. Becker, 1967: 109. Nafpaktitis & Nafpaktitis, 1969: 53, figs 67, 68.

Lampanyctus (*Lampanyctus*) *alatus* Fraser-Brunner, 1949: 1090, fig.

non *Myctophum* (*Lampanyctus*) *alatus*: Barnard, 1925: 240 (= *L. australis*).

Lampanyctus pusillus: Smith, 1961: 123 (*partim*).

Macrostoma alatum Fowler, 1936: 1232.

Macrostoma pusillum: Fowler, 1936: 1231 (*partim*).

Material

SAM 26105, 1 (50.0), St A 1236, 250-0 m.

SAM 26106, 1 (damaged), St A 1251, 500-0 m.

SAM 26107, 4 (16.1-25.0), St A 1896, 1 000-0 m.

SAM 26108, 4 (26.5-50.5), St A 2391, 820-0 m.

SAM 26109, 1 (21.0), St A 2965, 600-0 m.

SAM 26110, 6 (19.0-24.0), St A 2966, 600-0 m.

SAM 26111, 2 (damaged), St A 2968, 600-0 m.

SAM 26112, 2 (45.1-51.0), St A 4218, 1 400-0 m.

Description

D 13 (12); A 16 (17); P 12 (13); V 8; gill-rakers 3 (4) + 1 + 9 (8); AO_a6 (5); AO_p6 (7); total AO 12 (11-14).

Lampanyctus australis Tåning, 1932

Lampanyctus alatus australis Tåning, 1932: 145.

Myctophum (Lampanyctus) alatus: Barnard, 1925: 240.

Lampanyctus australis: Becker, 1967: 109. Nafpaktitis & Nafpaktitis, 1969: 54, figs 68, 69.

Material

- SAM 26113, 2 (49,0–103,5), St A 2394, 820–0 m.
- SAM 26114, 1 (25,0), St A 2958, 600–0 m.
- SAM 26115, 1 (31,5), St A 2967, 600–0 m.
- SAM 26116, 2 (50,0–92,0), St A 4218, 1 400–0 m.
- SAM 26117, 1 (71,0), St A 4229, 600–0 m.

Description

D 13; A 18 (17–19); P 14; V 8; gill-rakers 6 (7) + 1 + 13 (12–15); AO_a7 (8); AO_p8 (6–9); total AO 15 (14–16).

Remarks

Although *L. australis* resembles *L. alatus*, it can easily be distinguished by its higher AO and gill-raker counts and by the higher number of pectoral rays. While these counts for the above specimens fall within the range given by Nafpaktitis & Nafpaktitis (1969), SAM 26117 had a higher gill-raker count.

As in the Indian Ocean, the distribution of *L. australis* and *L. alatus* overlaps between 30°S and 40°S in the eastern South Atlantic. *L. australis* extends further north to about 23°S on the west coast than on the east coast of South Africa.

Lampanyctus pusillus (Johnson, 1890)

Scopelus pusillus Johnson, 1890: 457.

Lampanyctus pusillus Tåning, 1928: 66. Smith, 1961: 123 (*partim*), fig. 204. Bolin, 1959: 28.

Becker, 1967: 109. Nafpaktitis & Nafpaktitis, 1969: 52, figs 51, 66.

Macrostoma pusillum Fowler, 1936: 1231 (*partim*).

Lampanyctus (Lampanyctus) pusillus Fraser-Brunner, 1949: 1090, fig.

(For full synonymy see Bolin 1959: 28.)

Material

- SAM 26118, 4 (18,0–30,5), St A 1239, 1 000–500–0 m.
- SAM 26119, 1 (21,0), St A 1253, 500–0 m.
- SAM 26120, 3 (30,0–31,0), St A 1254, 500–0 m.
- SAM 26121, 1 (27,5), St A 3630, 1 000–0 m.
- SAM 26122, 2 (18,7–31,2), St A 4218, 1 400–0 m.

Description

D 13; A 15; P 14; V 8; gill-rakers 3 + 1 + 8; AO 4–5 + 6.

Lampanyctus ater-complex

As has been pointed out (Andriashev 1962; Nafpaktitis & Nafpaktitis 1969), the taxonomy of these species is confused and requires further investiga-

tion, especially with regard to the validity of *L. niger* and to clinal variations within species. The following identifications are therefore only tentatively advanced.

Lampanyctus ater Tåning, 1928

Lampanyctus ater Tåning, 1928: 68. Parr, 1928: 104, fig. 17. Bolin, 1959: 33. Becker, 1967: 116.

Nafpaktitis & Nafpaktitis, 1969: 44, figs 53, 54.

Lampanyctus (*Lampanyctus*) *ater* Fraser-Brunner, 1949: 1086, fig.

(For full synonymy see Bolin 1959: 33.)

Material

SAM 26123, 1 (110,5), St A 4218, 1 400–0 m.

Description

D 16; A 19; V 8; gill-rakers 5 + 1 + 11; AO 6–7 + 13–14.

Remarks

The specimen falls closest to *L. ater* in dorsal, anal and gill-raker counts. However, the upper Pol is anterior to the vertical from the last anal ray and SAO₃ is above the third anal ray. There are 5 + 1 infracaudal scales, the infracaudal gland extending about half-way along the peduncle.

Lampanyctus cf. *achirus* Andriashev, 1962

Lampanyctus achirus Andriashev, 1962: 256, fig. 27. Becker, 1967: 116. Nafpaktitis & Nafpaktitis, 1969: 45, figs 54, 55.

Material

SAM 26124, 4 (59,9–67,8), St A 4218, 1 400–0 m.

Description

D 15; A 18; V 8; gill-rakers 4 + 1 + 11 (10); AO 13–15.

Remarks

Gill-raker count, AO count and dorsal and anal counts separate these specimens from *L. lineatus* and *L. cuprarius*, and they differ from *L. ater* in the Prc/AO_p interspace, the position of AO_{p1} and the length of the infracaudal gland. They most closely resemble *L. achirus*: pectoral fins are absent; the infracaudal gland is more than 90% of the length of the caudal peduncle; AO_{p1} is above the last anal ray; and SAO₃ is above the fifth anal ray, behind the vertical from AO_{a1}.

Lepidophanes indicus Nafpaktitis & Nafpaktitis, 1969

Lepidophanes indicus Nafpaktitis & Nafpaktitis, 1969: 61, figs 72, 74, 75.

? *Lampanyctus pyrosobolus*: Grindley & Penrith, 1965: 283.

Material

- SAM 26125, 1 (29,6), St A 1236, 250–0 m.
 SAM 26126, 12 (12,5–22,2), St A 1239, 1 000–500–0 m.
 SAM 26127, 2 (21,5–24,2), St A 1254, 500–0 m.
 SAM 26128, 1 (26,5), St A 4229, 600–0 m.

Description

D 13; A 13 (14); P 13; V 8; gill-rakers 4 (3) + 1 + 11 (10); AO 6, (5–7) + 4 (3–5).

Remarks

All specimens have been referred to *L. indicus* because of the presence of a luminous patch above the pectoral fins, absence of a patch ventral to PVO₁, absence of luminous scales at the dorsal, AO count and gill-raker count. SAM 26128 from the Atlantic falls closer to *L. indicus* on the basis of the above, but possesses 4 luminous scales at the base of the anal fin and AO 7 + 3.

Ceratoscopelus warmingi (Lütken, 1892)

Scopelus (Nyctophus) warmingii Lütken, 1892: 259, fig. 19.

Myctophum (Lampanyctus) warmingi: Barnard, 1925: 237.

Lampanyctus warmingi: Fowler, 1936: 385, fig. 185.

Ceratoscopelus warmingi: Naefkritis & Naefkritis, 1969: 63, figs 76, 77.

Ceratoscopelus townsendi Fraser-Brunner, 1949: 1093 (*partim*), fig. Grindley & Penrith, 1965: 283.

Lampanyctus townsendi: Smith, 1961: 123.

Material

- SAM 26129, 3 (17,0–20,5), St A 1239, 1 000–500–0 m.
 SAM 26130, 2 (19,2–24,0), St A 4218, 1 400–0 m.

Description

D 14 (13); A 14; P 14; V 8; gill-rakers 4 + 1 + 10 (11); AO 7 (6) + 5.

Lobianchia dofleini (Zugmayer, 1911)

Myctophum (Lampanyctus) dofleini Zugmayer, 1911a: 3; 1911b: 35.

Myctophum dofleini Zugmayer, 1911b: 149, pl. 1, fig. 9.

Diaphus dofleini: Fowler, 1936: 402, fig. 200. Grindley & Penrith, 1965: 283.

Lobianchia dofleini: Bolin, 1959: 19. Becker, 1967: 98.

(For full synonymy see Bolin 1959: 19.)

Material

- SAM 26131, 1 (35,2), St A 4218, 1 400–0 m.
 SAM 26132, 2 (29,8–30,0), St A 4229, 600–0 m.

Description

D 16; A 14; P 12; V 8; gill-rakers 5 + 1 + 13; AO 5 + 5.

Remarks

The Prc photophores are equally spaced and Prc₄ is located on the extreme base of the caudal rays.

Diaphus cf. theta Eigemann & Eigemann, 1890

Diaphus theta Eigemann & Eigemann, 1890: 4. Fraser-Brunner, 1949: 1074, fig. Fowler, 1936: 407. Grindley & Penrith, 1965: 283. Becker, 1967: 102, fig. 6.

Material

SAM 26133, 1 (51,5), St A 2391, 820-0 m.
 SAM 26134, 1 (damaged), St A 2394, 820-0 m.
 SAM 26135, 19 (27,0-71,0), St A 4229, 600-0 m.

Description

D 14 (13-15); A 13 (12-14); P 11 (10-13); V 8; gill-rakers 8 + 1 + 16 (17); AO 4 (5) + 5 (6).

Remarks

The specimens fall closer to *D. theta* than to other species in this complex because of the gill-raker count, a separate AO_p/Prc series, and because AO_a1 is not elevated. Wisner (personal communication) is of the opinion that specimens referred to *D. theta* from the South Atlantic may prove to be specifically distinct from those off southern California, the type locality.

Diaphus ostenfeldi Tåning, 1932

Diaphus ostenfeldi Tåning, 1932: 142 fig. 15. Becker 1967: 107. Trunov, 1968: 747, fig. 2.
Diaphus (Lamprossa) ostenfeldi Fraser-Brunner, 1949: 1072, fig.
Aethopora ostenfeldi Bolin, 1959: 22.

Material

SAM 26136, 7 (61,4-73,0), St A 4229, 600-0 m.

Description

D 16 (15-17); A 15 (16); P 11; V 8 (7); gill-rakers 8 (9-10) + 1 + 15 (16), total 24-26; Pol 3; AO 5 + 5 (6).

Remarks

The 3 Pol organs are not included in the AO_a count. One specimen with AO_p6 on the one side, the sixth AO_p reduced in size.

Scopelopsis multipunctatus Brauer, 1906

Scopelopsis multipunctatus Brauer, 1906: 146, fig. 71. Barnard, 1925: 246. Norman, 1930: 318. Fraser-Brunner, 1949: 1099, fig. Smith, 1961: 118, fig. 191. Grindley & Penrith, 1965: 283. Nafpaktitis & Nafpaktitis, 1969: 67, figs 47, 82.

Material

- SAM 26137, 9 (16,9-19,3), St A 1254, 500-0 m.
 SAM 26138, 1 (62,0), St A 4218, 1 400-0 m.
 SAM 26139, 8 (63-67), St A 4229, 600-0 m.

Family Bregmacerotidae*Bregmaceros mcclellandii* Thompson, 1840

- Bregmaceros mcclellandii* Thompson, 1840: 185, figs. Fowler, 1936: 1254.
Bregmaceros maclellandi: Gilchrist & Thompson, 1914: 87; 1916: 319. Norman, 1930: 339.
 Smith, 1961: 137, fig. 251. Grindley & Penrith, 1965: 283.
Bregmaceros maclellandi: Barnard, 1925: 325.
Bregmaceros maclellandi: D'Acona & Cavinato, 1965: 66, figs 1, 54-58.

Material

- SAM 26147, 1 (32), St A 2961, 700-0 m.
 SAM 26148, 2 (26-30), St A 3643, 1 000-0 m.

Family Melanonidae*Melanonus gracilis* Günther, 1878

- Melanonus gracilis* Günther, 1878: 19; 1887: 84, pl. 14, fig. B. Brauer, 1906: 277, pl. 12, fig. 5.
 Barnard, 1925: 332. Norman, 1930: 340. Fowler, 1936: 1252, fig. 538. Smith, 1961: 140,
 fig. 261. Grindley & Penrith, 1965: 283.

Material

- SAM 26149, 1 (132), St A 1888, 1 000-0 m.
 SAM 26150, 1 (68), St A 2957, 700-0 m.
 SAM 26151, 1 (95), St A 2958, 600-0 m.
 SAM 26152, 1 (48), St A 2958, 600-0 m.
 SAM 26153, 1 (104), St A 2961, 700-0 m.
 SAM 26154, 1 (41), St A 2963, 600-0 m.
 SAM 26155, 1 (62), St A 3643, 1 000-0 m.

Remarks

Although a second species, *M. zugmayeri* Norman, has been described, all specimens have been referred to *M. gracilis* because of the narrower body depth and the comparatively feeble dentition.

Family Trachipteridae*Trachipterus* sp.*Material*

- SAM 26302, 1 (4,0), St A 2963, 600-0 m.

Remarks

This specimen is a larval form. At present three species, *T. iris*, *T. cristatus* and *T. arcticus*, are known from the southern African region (Smith 1961).

Family **Melamphaeidae**

Material

- SAM 26580, 1 (17,0), St A 1239, 1 000–500–0 m.
 SAM 26581, 2 (14,0–15,2), St A 1247, 1 500–0 m.
 SAM 26582, 1 (13,4), St A 1247, 1 500–0 m.
 SAM 26583, 6 (13,0–22,8), St A 1254, 500–0 m.
 SAM 26584, 1 (damaged), St A 1254, 500–0 m.
 SAM 26585, 1 (41,5), St A 1879, 1 000–0 m.
 SAM 26586, 6 (12,0–22,2), St A 1892, 1 000–0 m.
 SAM 26587, 2 (12,2–12,8), St A 1894, 500–0 m.
 SAM 26588, 7 (12,5–17,0), St A 1894, 500–0 m.
 SAM 26589, 8 (15,8–20,2), St A 1896, 1 000–0 m.
 SAM 26590, 1 (16,9), St A 2945, 700–0 m.
 SAM 26591, 1 (126,0), St A 2957, 700–0 m.
 SAM 26592, 1 (28,8), St A 2958, 600–0 m.
 SAM 26593, 1 (32,0), St A 2958, 600–0 m.
 SAM 26594, 4 (10,0–18,0), St A 2966, 600–0 m.
 SAM 26595, 1 (17,0), St A 2967, 600–0 m.
 SAM 26596, 1 (103,2), St A 3616, 1 000–0 m.
 SAM 26597, 2 (41,5–87,0), St A 3616, 1 000–0 m.
 SAM 26598, 1 (32,2), St A 3632, 1 000–500–0 m.
 SAM 26599, 2 (22,0–24,1), St A 4218, 1 400–0 m.
 SAM 26600, 1 (24,6), St A 4218, 1 400–0 m.

Remarks

The following species are probably represented in the collection: *Scopeloberyx robustus*, *S. microlepis*, *Melamphaes microps*, *M. suborbitalis*, *Sio nordenskjoldii*, *Scopelogadus beanii*, *Poromitra macrophthalma* and *P. atlantica*.

Family **Diretmidae**

Diretmus argenteus Johnson, 1863

Diretmus argenteus Johnson, 1863: 403, pl. 36, fig. 2. Günther, 1887: 45. Zugmayer, 1911b: 107, pl. 5, fig. 7. Barnard & Von Bonde, 1944: 237, fig. Smith, 1961: 150, fig. 285.

Diretmus aureus: Günther, 1887: 45.

Material

- SAM 26303, 1 (7), St A 1894, 500–0 m.
 SAM 26229, 1 (51), St A 3634, 1 000–500–0 m.

Family **Scomropidae**

Howella brodiei Ogilby, 1899

Howella brodiei Ogilby, 1899: 735.

Rhectogramma sherborni Norman, 1930: 348, fig. 39. Fowler, 1936: 1287, fig. 547.

Howella sherborni: Smith, 1961: 212, fig. 498. Grindley & Penrith, 1965: 284.

Material

- SAM 26140, 1 (31,7), St A 2394, 820–0 m.
 SAM 26141, 3 (39–82), St A 3643, 1 000–0 m.
 SAM 26142, 2 (55–74), St A 4218, 1 400–0 m.

Description

D VIII + I, 9; A III, 7; P 14–15; V I, 5; gill-rakers 7 + 1 + 21.

Family Chiasmodontidae*Chiasmodon niger* Johnson, 1863

Chiasmodon niger Johnson, 1863: 408; 1864: 76. Jordan & Evermann, 1896: 2291. Norman, 1930: 349. Fowler, 1936: 1031, fig. 424. Smith, 1961: 176, fig. 377. Grindley & Penrith, 1965: 284.

Material

- SAM 26146, 1 (52), St A 2958, 600–0 m.

Description

D X + I, 28; A 28; P 13.

Family Bramidae*Pterycombus* cf. *petersii**Material*

- SAM 26236, 1 (15,7), St A 1229, 300–0 m.
 SAM 26237, 1 (19,5), St A 1232, 250–0 m.
 SAM 26238, 1 (14,0), St A 1234, 250–0 m.

Remarks

Two species, *P. falcatus* and *P. petersii*, are at present known from the southern African region. These specimens appear to fall closest to *P. petersii*.

Family Brotulidae*Neobythites macrops* Günther, 1887

Neobythites macrops Günther, 1887: 102, pl. 20, fig. A. Gilchrist & Thompson, 1914: 89; 1916: 416. Gilchrist & Von Bonde, 1924: 19. Norman, 1939: 84. Smith, 1961: 363, fig. 1019. *Neobythites analis* Barnard, 1925: 879.

Material

- SAM 26579, 1 (54,0), St A 2958, 600–0 m.

Family Gempylidae*Epinnula orientalis* Gilchrist & Von Bonde, 1924

Epinnula orientalis Gilchrist & Von Bonde, 1924: 15, pl. 4, fig. 1. Barnard, 1925: 790. Smith, 1961: 311, fig. 865.

Material

SAM 26304, 1 (damaged), St A 1229, 300–0 m.

Family Ceratiidae

Cryptopsaras couesi Gill, 1883

Cryptopsaras couesi Gill, 1883: 284. Günther, 1887: 55. Smith, 1961: 428, fig. 1229.
Ceratias couesi Brauer, 1906: 317, pl. 15, fig. 7.

Cryptopsaras couesi: Bertelsen, 1951: 139, figs 93–97.
 (For full synonymy see Bertelsen 1951: 139.)

Material

SAM 26230, 1 (37,2), St A 3632, 1 000–500–0 m.

Family Scorpaenidae

Helicolenus dactylopterus dactylopterus (Delaroche, 1809)

Scorpaena dactyloptera Delaroche, 1809: 337, pl. 22, fig. 9.
Helicolenus maculatus: Gilchrist, 1922: 75. Barnard, 1925: 907. Davies, 1949: 26. Smith, 1961: 369, pl. 83, fig. 1034. Grindley & Penrith, 1965: 284.
Sebastes maculatus Cuvier & Valenciennes, 1829: 343.
Helicolenus dactylopterus dactylopterus Eschmeyer, 1969: 93.
 (For full synonymy see Eschmeyer 1969: 93.)

Material

SAM 26578, 1 (16,0), St A 3634, 1 000–500–0 m.

Family Nemichthyidae

Borodinula infans (Günther, 1878)

Nemichthys infans Günther, 1878: 251; 1887: 264, pl. 63, fig. B.
Avocettina infans: Barnard, 1925: 199. Fowler, 1936: 283, fig. 133. Smith, 1961: 391. Grindley & Penrith, 1965: 283. Blache *et al.*, 1970: 223, fig. 607 a, b.

Material

SAM 26231, 1 (492), St A 2393, 820–0 m.

SAM 26232, 1 (385), St A 2958, 600–0 m.

SAM 26234, 1 (damaged), St A 2961, 700–0 m.

Nemichthys scolopaceus Richardson, 1848

Nemichthys scolopaceus Richardson, 1848: 25, pl. 10, figs 1–3. Brauer, 1906: 126, pl. 9, fig. 1. Roule, 1910: 1, pl. 1, figs 1–7. Barnard, 1925: 198. Blache *et al.*, 1970: 224, fig. 608.
Nemichthys scolopacea Günther, 1887: 263. Fowler, 1936: 286, fig. 134. Smith, 1961: 391, fig. 1107. Grindley & Penrith, 1965: 283.

Material

SAM 26234, 1 (735), St A 2394, 820–0 m.

Family **Serrivomeridae**

Serrivomer beanii Gill & Ryder, 1883

Serrivomer beanii Gill & Ryder, 1883: 260. Fowler, 1936: 283, fig. 132. Smith, 1961: 392, fig. 1109.
Serrivomer beani: Barnard, 1925: 200. Grindley & Penrith, 1965: 283. Blache *et al.*, 1970: 223, fig. 606.

Material

SAM 26235, 1 (402), St A 3632, 1 000–500–0 m.

SUMMARY

A collection of mesopelagic fishes from the Deep-sea Stations of *Africana II* is described. The material is from the eastern South Atlantic and western South Indian Oceans, and includes approximately 75 species, of which 10 are new records.

ACKNOWLEDGEMENTS

I am grateful to the Director, Division of Sea Fisheries, Cape Town, for the donation of the mesopelagic fish collection and to Dr A. de Dekker and Mr A. Robertson, of the Division, for their help. My thanks are also due to Dr G. Krefft, Institut für Seefischerei, Hamburg, and Mr R. Wisner, Scripps Institution of Oceanography, La Jolla, for their helpful comments. I should also like to thank Mr S. X. Kannemeyer, Department of Marine Biology, South African Museum, for his assistance during all phases of this work.

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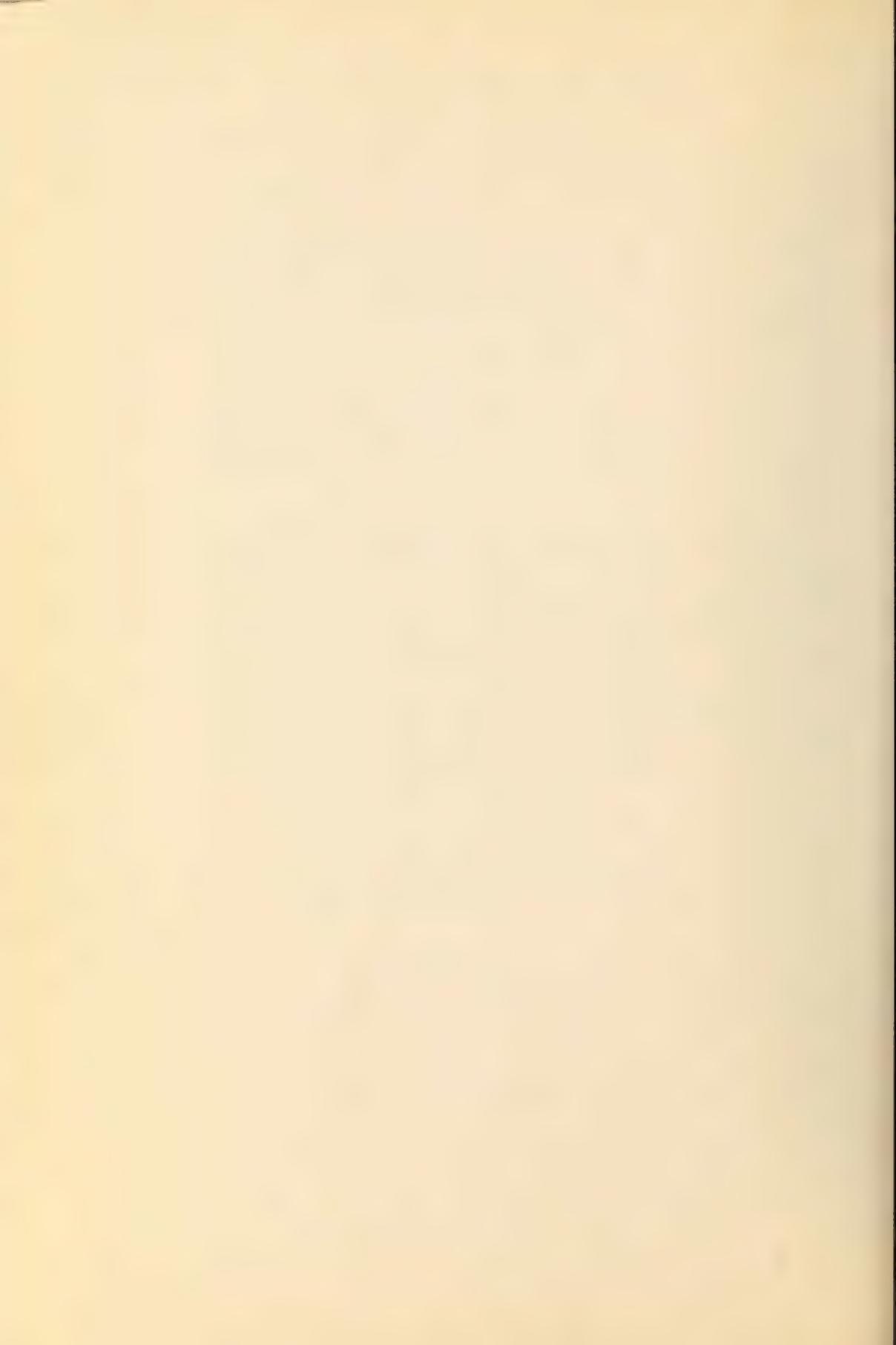
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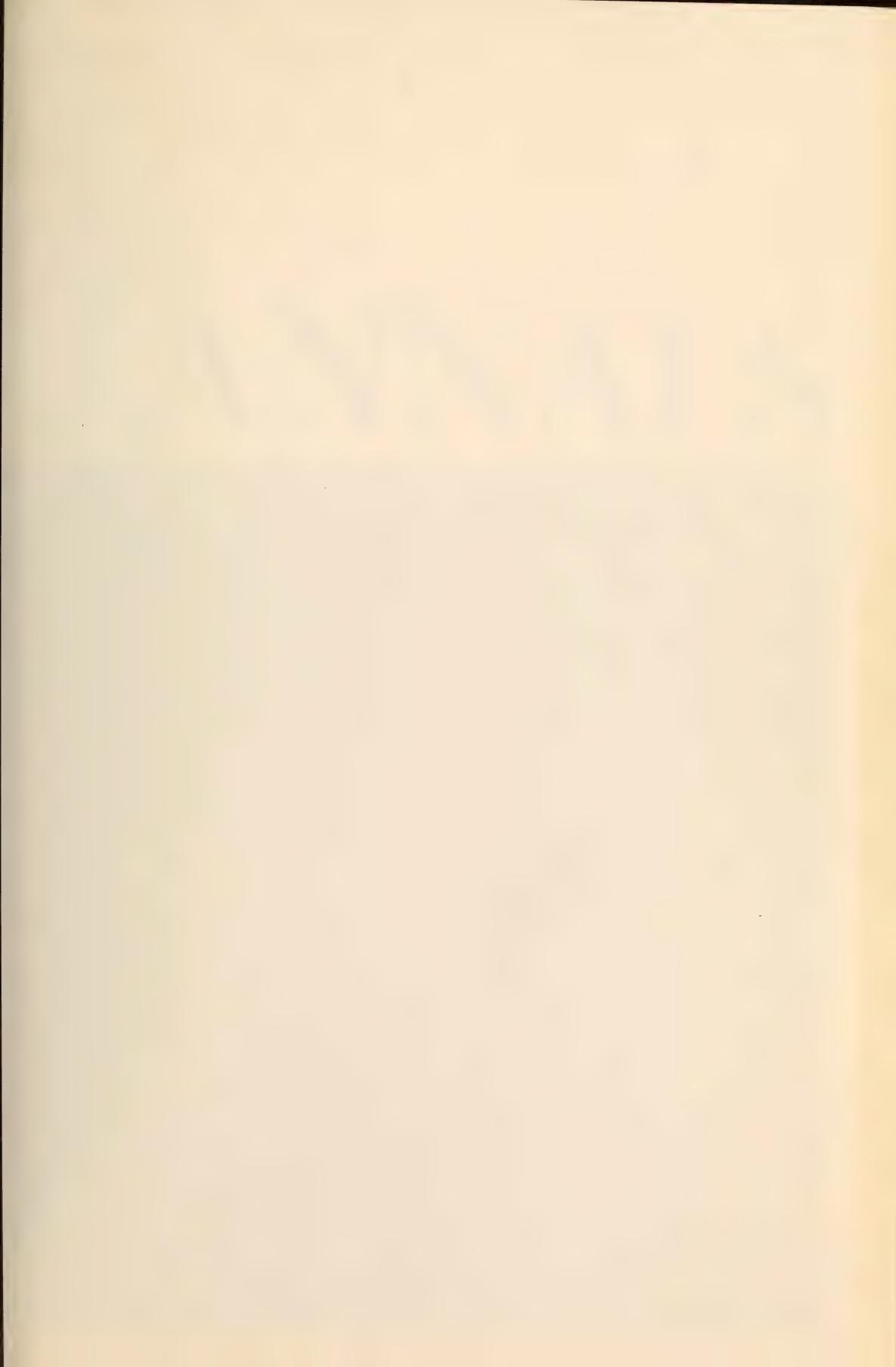
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Example

Scalaria coronata Lamarck, 1816: pl. 451, figs 5 *a*, *b*; Liste: 11. Turton, 1932: 80.





P. A. Hulley

A REPORT ON THE MESOPELAGIC FISHES
COLLECTED DURING THE DEEP-SEA CRUISES
OF R.S. 'AFRICANA II', 1961-1966

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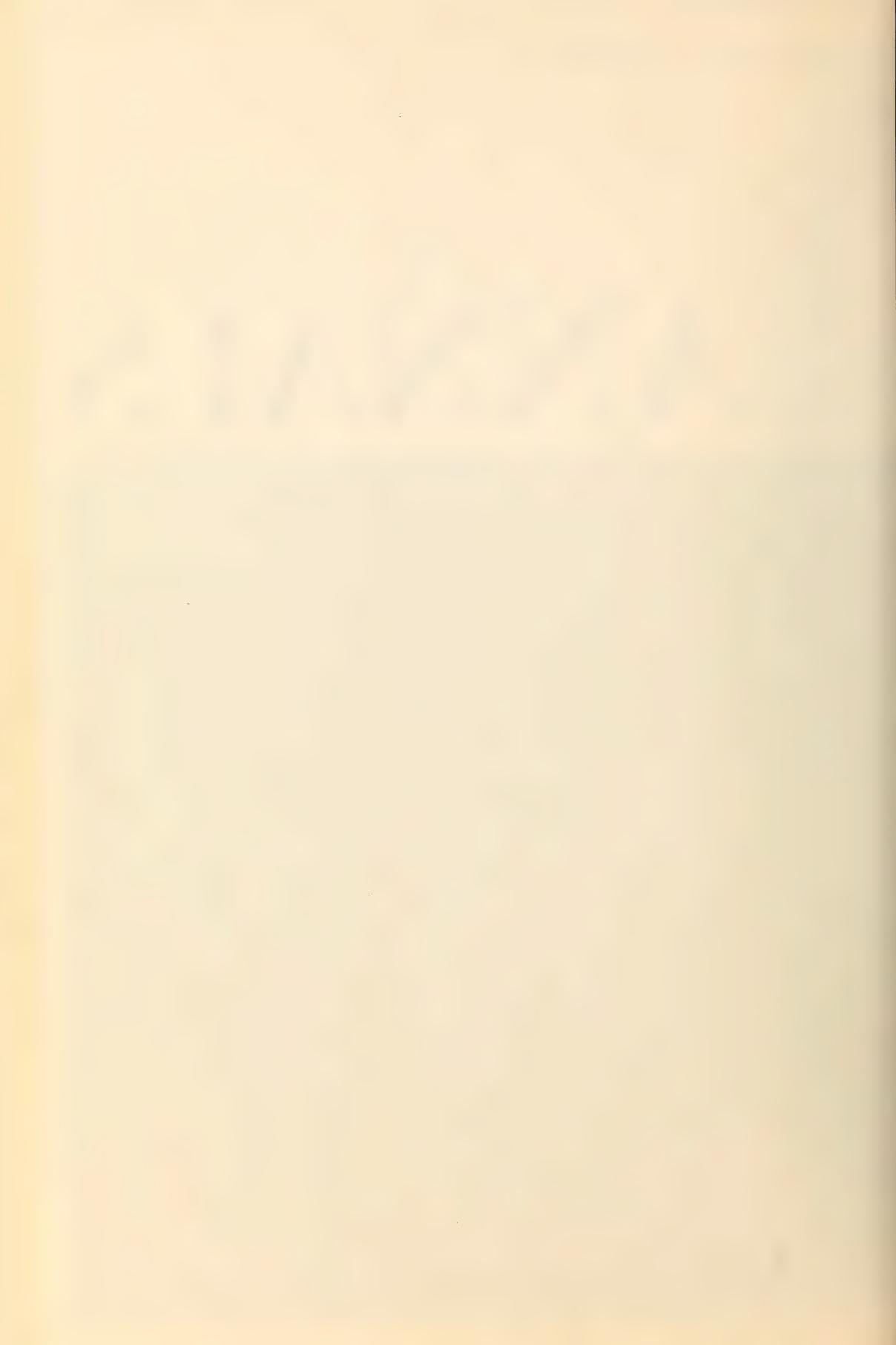
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MESOPELAGIC FISHES
FROM VEMA SEAMOUNT
(IK STATION 52)

By

P. A. HULLEY

Cape Town Kaapstad

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1, 2(1, 3, 5, 7-8), 3(1-2, 5, t.-p.i.), 5(1-2, 5, 7-9),
6(1, t.-p.i.), 7(1-3), 8, 9(1-2), 10(1),
11(1-2, 5, 7, t.-p.i.), 24(2), 27, 31(1-3), 33

Price of this part/Prys van hierdie deel

R1,70

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1972

ISBN 0 949940 21 6

Printed in South Africa by
The Rustica Press, Pty., Ltd,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

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(IK Station 52)

By

P. A. HULLEY

South African Museum, Cape Town

(With 2 figures)

[Ms. accepted 20 June 1972]

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INTRODUCTION

In 1960, a survey of the mesopelagic fauna of the seas around South Africa was undertaken by the South African Museum (Grindley & Penrith 1965), as part of an investigation of the forage organisms of tuna. A 10 ft Isaacs-Kidd midwater-trawl was employed and a total of 45 stations were occupied between October 1960 and April 1963 (IK 4-7, 10-48, 50-51).

In November 1966, during a survey of the Vema Seamount by the R.S. *Thomas B. Davey*, a further station (IK 52: 31°38'S, 8°21.5'E, 5-XII-66/6-XII-66, 2130-0530 (480 mins), 500-0 m) was occupied using the same IKMT and starting from the south of the Seamount and working around the west to the north side.

This paper represents the ichthyological results of that station.

SYSTEMATIC DISCUSSION

Family **Searsiidae**

Perspasia kopua (Phillips, 1942)

Bathyroctes kopua Phillips, 1942: 49, pl. 16, fig. 1.

Perspasia kopua Parr, 1960: 48, fig. 33. Matsui & Rosenblatt, 1971: 477. Hulley, 1972: 203, fig. 2;

Bathyroctes rostratus Norman, 1930: 268, fig. 1, pl. 2, fig. 3.

Perspasia taningi Parr, 1951: 18; 1960: 50, figs 35, 36. Tucker, 1954: 208 (*partim*).

Material

SAM 26601, 1 (28.0 mm).

Description

D 21; A 14; P 20; V 9; gill-rakers 9+1+24. Photospores: oo 2; 100; POO absent; BRO 7; JO; IPO; SPO; THO 3; SVO; IVO; AO; SAO; PAO; CO; PO; GO₂.

Family **Gonostomatidae**

Photichthys argenteus Hutton, 1873

Phosichthys argenteus Hutton, 1873: 269 (*lapsus calami*).

Photichthys argenteus Hutton, 1873: 269, pl. 15, fig. 90. Günther, 1887: 178, pl. 45, fig. A. Goode & Bean, 1895: 104 pl. 32, fig. 122. Brauer, 1906: 92, fig. 37. Gilchrist, 1922: 55. Barnard, 1925: 150. Norman, 1930: 292, pl. 2, figs 1, 2. Smith, 1961: 104, fig. 153. Grey, 1960: 100; 1964: 84. Grindley & Penrith, 1965: 282. Hulley, 1972: 205.

Material

SAM 26603, 13 (28.2–46.0 mm).

Ichthyococcus sp.

Material

SAM 26602, 1 (64.3 mm).

Remarks

The specimen has been sent to Dr G. Krefft, and is to be described in a revision of the genus by this author.

Cyclothona spp.

Material

SAM 26604, 48 (23.5–29.4 mm).

Family **Sternopychidae**

Argyropelecus gigas Norman, 1930

Argyropelecus gigas Norman, 1930: 302, fig. 10. Fowler, 1936: 1208. Schultz, 1938: 147; 1961: 600, fig. 5; 1964: 250, fig. 64. Blache, 1964: 74, fig. Baird, 1971: 38, fig. 24. Hulley, 1972: 208.

Argyropelecus affinis: Jespersen 1915: fig.

Material

SAM 26605, 2 (22.5–66.9 mm).

Argyropelecus hemigymnus Cocco, 1829

Argyropelecus hemigymnus Cocco, 1829: 146. Brauer, 1906: 106, fig. 45. Zugmayer, 1911: 51. Murray & Hjort, 1912: 612. Gilchrist, 1913: 66. Pappenheim, 1914: 182. Barnard, 1925: 153. Norman, 1930: 303, pl. 2, fig. 4. Schultz, 1937: 4; 1961: 601, fig. 6. Smith, 1961: 107, fig. 160. Blache, 1964: 76. Grindley & Penrith, 1965: 282. Baird, 1971: 42, fig. 28. Hulley, 1972: 208.

(For full synonymy see Schultz 1961: 601).

Material

SAM 26606, 5 (20.8–31.0 mm).

Family **Chauliodontidae**

Chauliodus sloani Bloch & Schneider, 1801

Chauliodus sloani Bloch & Schneider, 1801: 430. Cuvier & Valenciennes, 1849: 382. Goode & Bean, 1895: 96, fig. 115. Gilchrist, 1913: 66; 1922: 42. Fowler, 1936: 219. Smith, 1961: 102, fig. 145. Morrow, 1964: 283, fig. 74. Grindley & Penrith, 1965: 282. Gibbs & Hurwitz, 1967: 798, figs 1–3. Hulley, 1972: 210.

Chauliodus sloanii: Günther, 1887: 179.

Chauliodus sloanei: Brauer, 1906: 40, figs 7–9. Pappenheim, 1914: 167. Barnard, 1925: 141. Regan & Trewavas, 1929: 32, fig. 24. Norman, 1930: 308; 1939: 21.

(For full synonymy see Morrow 1964: 287.)

Material

SAM 26607, 4 (144–192 mm).

Family **Scopelarchidae***Neoscopelarchoides* sp.

Fig. 1

Neoscopelarchoides sp. Marshall, 1955: 311, fig. 3.*Material*

SAM 26608 1 (49,9 mm).

Remarks

This specimen is a late larval stage. The lingual teeth resemble those figured by Marshall (1955: fig. 3 a¹).

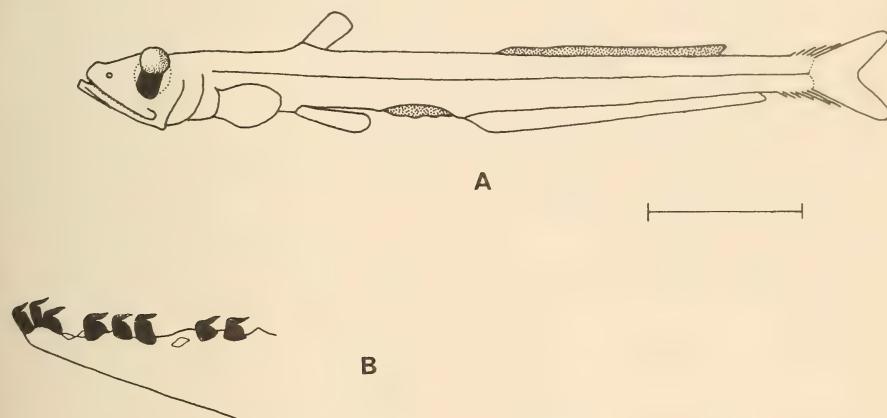


FIG. 1. *Neoscopelarchoides* sp. (SAM 26608). A. Lateral view. B. Lingual teeth. Scale 10 mm.

Family **Scopelosauridae***Luciosudis normani* Fraser-Brunner, 1931

Luciosudis normani Fraser-Brunner, 1931: 220, fig. 2. Krefft, 1968: 95, figs 1-4.
Scopelosaurus normani Marshall, 1966: 196.

Material

SAM 26610, 1 (47,5 mm).

Description

D 11; A 18; gill-rakers 1+1+28; Vert 58.

Remarks

The specimen has been identified by Dr G. Krefft, Hamburg.

Family **Myctophidae***Protomyctophum (Hierops) subparallelum* (Tåning, 1932)*Myctophim arcticum subparallelum* Tåning, 1932: 128.*Electrona (Hierops) arctica subparallelula* Fraser-Brunner, 1949: 1047.*Hierops subparallelula* Bolin, 1959: 5.

Protomyctophum (Hierops) subparallelum Andriashev, 1962: 243, figs 14, 15. Nafpaktitis & Nafpaktitis, 1969: 8, figs 4-6. Hulley, 1972: 219.

(For full synonymy see Andriashev 1962: 243.)

Material

SAM 26609, 9 (damaged).

Description (composite)

D 11-12; A 21; P 15; V 8; gill-rakers 4+1+14 (13); AO 15.

Remarks

The heads of all the specimens are missing and the sides of the bodies are badly scraped. They have been identified as this species because:

- (1) PLO not reduced in size and situated in front of PVO_1 ;
- (2) anal origin below middle of dorsal;
- (3) AO 15, in unbroken series, with 3 photophores behind anal base;
- (4) Last AO separated from Prc_1 by distance greater than Prc_1-Prc_2 .

Electrona rissoi (Cocco, 1829)

Scopelus rissoi Cocco, 1829: 15, pl. 2, fig. 5.

Myctophum rissoi: Brauer, 1906: 170, fig. 83. Norman, 1930: 320. Fowler, 1936: 380, fig. 184.

Electrona (Electrona) rissoi Fraser-Brunner, 1949: 1048, fig.

Electrona rissoi Bolin, 1959: 5. Becker, 1967: 92. Trunov, 1968: 745, fig. 1. Nafpaktitis & Nafpaktitis, 1969: 10, figs 4, 6, 8. Hulley, 1972: 220.

(For full synonymy see Bolin 1959: 5.)

Material

SAM 26611, 4 (47.1-64.6 mm).

Description

D 13; A 18-20; P 15 (16); V 8; gill-rakers 8+1+18 (19); AO 11; $Prc\ 2$.

Diaphus effulgens (Goode & Bean, 1896)

Aethopora effulgens Goode & Bean, 1896: 87, pl. 27, fig. 103. Jordan & Evermann 1896: 566.

Myctophum (Nyctophum) effulgens Brauer, 1904: 393.

Diaphus effulgens Tåning, 1928: 62. Nafpaktitis, 1968: 70, figs 44-46.

Diaphus (Lamprossa) effulgens Fraser-Brunner, 1949: 1071, fig.

Diaphus elucens: Smith, 1961: 122, fig. 201 (*partim*).

(For full synonymy see Nafpaktitis 1968: 70.)

Material

SAM 26612, 1 (99.8 mm).

Description

D 16; A 15; P 12; V 8; gill-rakers 6+1+13 = 20. Lateral line scales 36. AO 6+5; $Prc\ 4$; PLO nearer pectoral base than lateral line; Dn extending higher than level of dorsal margin of eye.

Lampanyctus australis Tåning, 1932

Lampanyctus alatus australis Tåning, 1932: 145.

Myctophum (Lampanyctus) alatus: Barnard, 1925: 240.

Lampanyctus australis: Becker, 1967: 109. Nafpaktitis & Nafpaktitis, 1969: 54, figs 68, 69. Hulley, 1972: 224.

Material

SAM 26613, 5 (89.1-103.4 mm).

Description

D 13 (14); A 18 (19); P 14 (15); V 8; gill-rakers 6 (5)+1+13 (12). AOa 8 (7); AOp 7 (8); total AO 15.

Lepidophanes supralateralis (Parr, 1928)

Fig. 2

Lampanyctus supralateralis Parr, 1928: 94, fig. 12.*Lampanyctus* (*Lepidophanes*) *supralateralis* Fraser-Brunner, 1949: 1091, fig.*Lepidophanes supralateralis* Bolin, 1959: 34.? *Lampanyctus superlateratus*: Grindley & Penrith, 1965: 283 (*lapsus calami*).*Material*

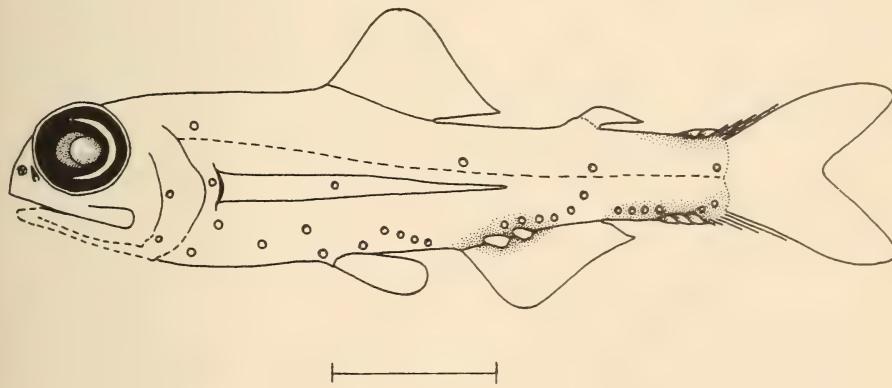
SAM 26614, 1 (45.3 mm).

Description

D 13; A 14; P 14; V 8; gill-rakers $6+1+12 = 19$. Crescent of luminous tissue on posterior rim of iris; PLO, SAO₃, Pol and Prc₃ just above lateral line; VLO well below lateral line; PO 5, the fourth elevated; VO 5, the posterior four forming a straight descending series from elevated second; SAO 3, weakly angulate; AO 5+4; Pol 2; Prc 3, well separated from AOP; 2 supracaudal and 3 infracaudal plates; 4 luminous scales on base of anal.

Remarks

This specimen represents the first record of the species in the eastern South Atlantic. Grindley & Penrith (1965) have recorded specimens as *L. superlateratus* Parr from the south-western Indian Ocean.

FIG. 2. *Lepidophanes supralateralis* (Parr). Scale 10 mm.

Family Melamphaeidae

Melamphaes suborbitalis (Gill, 1883)*Plectromus suborbitalis* Gill, 1883: 258. Norman, 1929: 157.*Melamphaes suborbitalis* Günther, 1887: 30. Fowler, 1936: 1265 (*partim*). Ebeling, 1962: 56, fig. 23.

(For full synonymy see Ebeling 1962: 56.)

Material

SAM 26615, 1 (76.0 mm).

Description

D III, 16; A I, 8; P 15; V I, 7, inserted behind origin of pectoral; gill-rakers (1st arch) 6+15; gill-rakers (4th arch) 11 on lower limb. 3 pores on cheek inside angle. Sharp, antrose, posttemporal spine present.

Remarks

Although the possible existence of this species in the South Atlantic has already been reported (Hulley 1972), this specimen represents the first record of the species in the region.

Family **Scombridae***Howella brodiei* Ogilby, 1899

Howella brodiei Ogilby, 1899: 735. Hulley, 1972: 229.

Rectogramma sherborni Norman, 1930: 348, fig. 39. Fowler, 1936: 1287, fig. 547.

Howella sherborni: Smith, 1961: 212, fig. 498. Grindley & Penrith, 1965: 284.

Material

SAM 26616, 1 (77.8 mm).

Description

D VIII+I, 9; A III, 7; P 15; V I, 5; gill-rakers 7+1+21.

Family ? **Percichthyidae***Material*

SAM 26617, 1 (31.1 mm).

Remarks

The specimen has been badly damaged by the net, so that fin counts are difficult to assess.

SUMMARY

A collection of mesopelagic fishes is described. The material was taken at 31°38'S, 8°21.5'E (IK 52) during the survey cruise of R.S. *Thomas B. Davey* to Vema Seamount, and includes 16 species, of which 2 are new records.

ACKNOWLEDGEMENTS

I am grateful to the Department of Oceanography, University of Cape Town, and Prof. J. R. Grindley, formerly of the South African Museum, for arranging the Vema cruise. I also wish to thank Mr M. J. Penrith for his help on board, and Mr S. X. Kannemeyer for his assistance with sorting the material.

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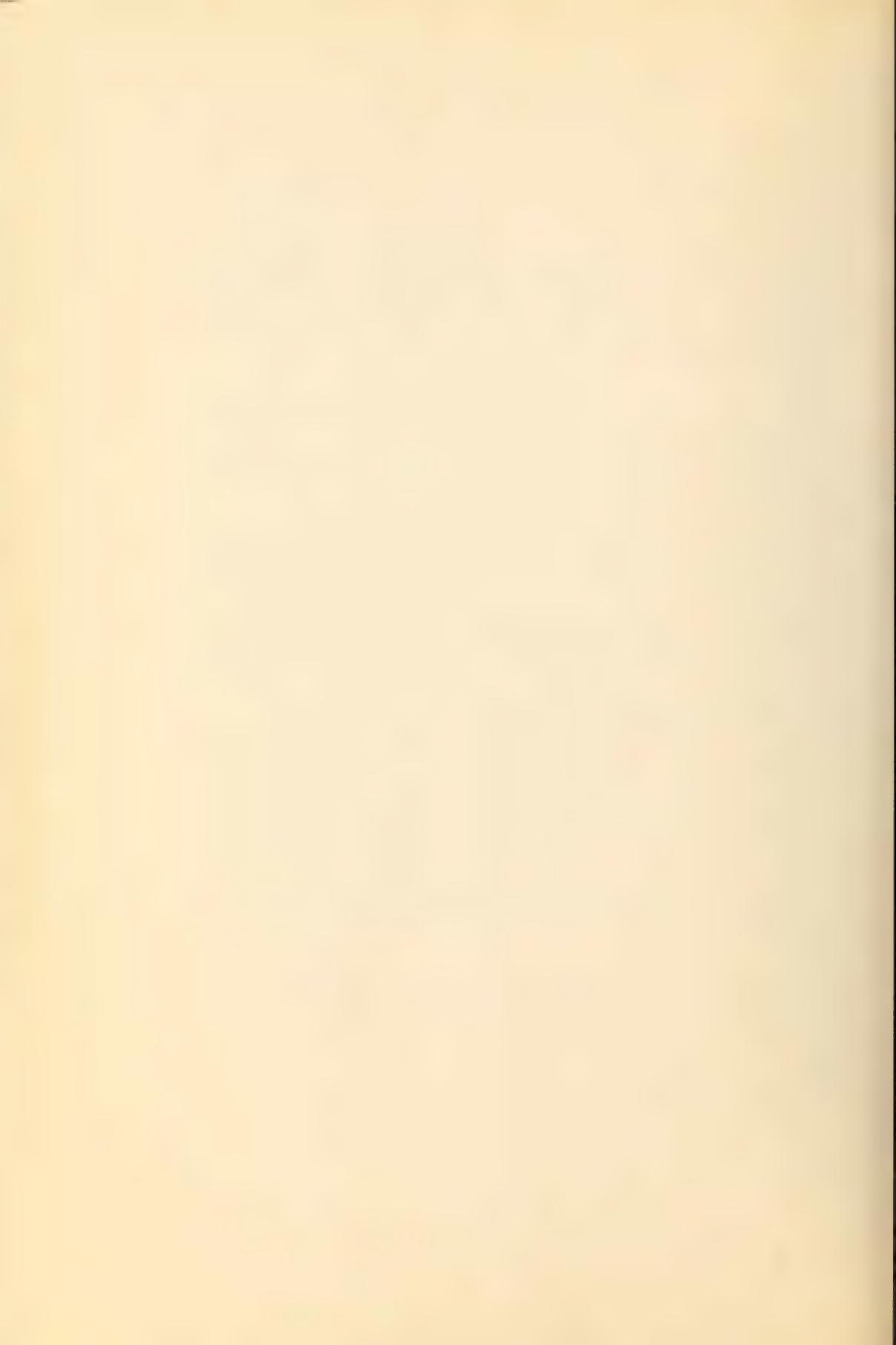
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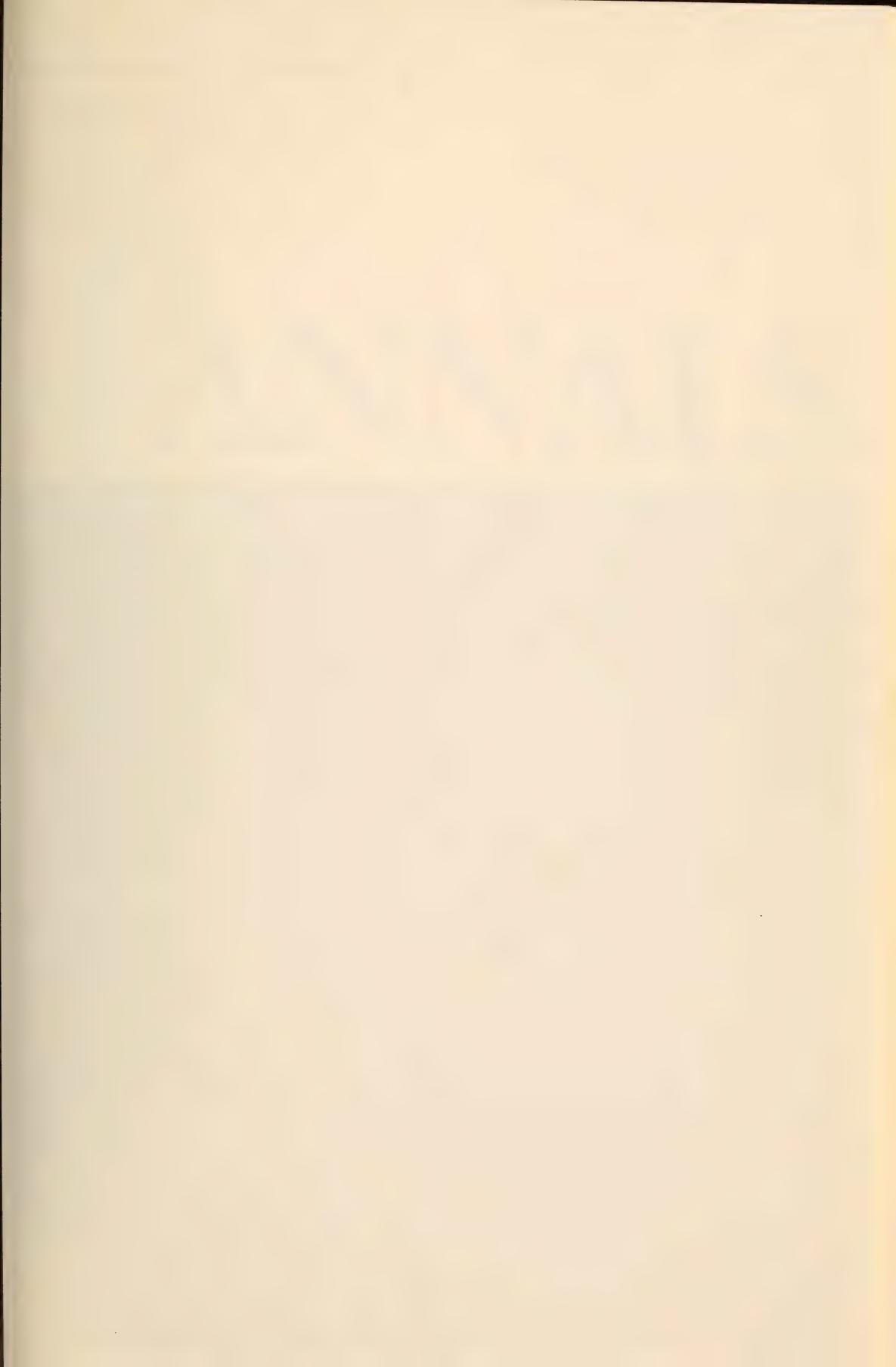
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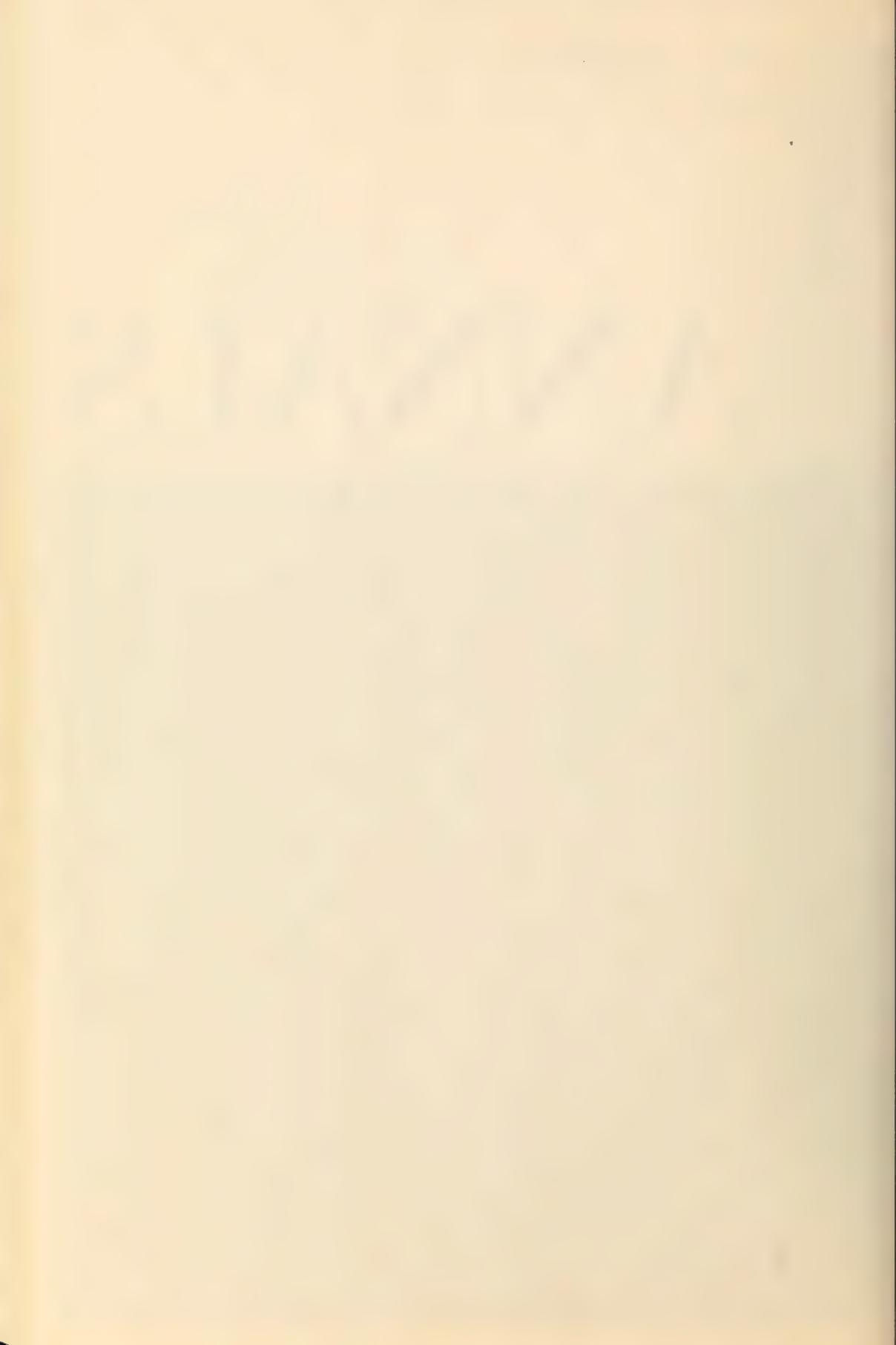
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THE CRETACEOUS STRATIGRAPHY OF
SAN NICOLAU AND SALINAS, ANGOLA

By

MICHAEL R. COOPER

Cape Town Kaapstad

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1, 2(1, 3, 5, 7-8), 3(1-2, 5, t.-p.i.), 5(1-2, 5, 7-9),
6(1, t.-p.i.), 7(1-3), 8, 9(1-2), 10(1),
11(1-2, 5, 7, t.-p.i.), 24(2), 27, 31(1-3), 33

Price of this part/Prys van hierdie deel

R1,85

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1972

ISBN 0 949940 23 2

Printed in South Africa by
The Rustica Press, Pty., Ltd,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

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MICHAEL R. COOPER

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(With 2 figures)

[MS. accepted 29 June 1972]

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INTRODUCTION

The paucity of ammonites within much of the Cretaceous of Angola has led to the widespread use of other taxa, such as bivalves, echinoids and shark's teeth as stratigraphic indicators, often with somewhat spurious results.

Mouta & Borges (1926), in studying the stratigraphy of the Benguela and Moçâmedes basins, recognized the following stratigraphical succession:

- Formations with *Roundaireia forbesiana* Stoliczka and *R. d'rui* Munier-Chalmas—Senonian
Beds of sandy and oolitic limestones with *Acteonaella anchietai* Choffat and *Nerinea capelloi* Choffat—Turonian
Strata with *Neithea tricostata* Coquand—Cenomanian
Limestones and shales with ammonites (*Douvilleiceras mammillatum* (Schlotheim) and *Stoliczkaia dispar* (d'Orbigny))—Albian
Strata with *Pholadomya pleuromyaiformis* Choffat—Albian
Lower formations with gypsum—Aptian

These authors noted that at San Nicolau the Senonian overlies red arenites, and they mentioned a basaltic layer within the former. The Senonian beds underlying the basalts were considered Coniacian on the basis of the similarity of the fauna to that from the Coniacian of Tunis, including *Pecten virgatus* Nils, *Trigonarca* cf. *trichonopolytensis* Forbes, *Trigonia scabra* Lamarck, *Cyprina* (*Veniliocardia*) cf. *barroisi* Coquand, *Roundaireia forbesiana* Stoliczka, *Venus plana* J. Sowerby and *Corbula elegans* J. de C. Sowerby. They noted that the beds overlying the basalts contained *Crassatella numidica* Munier-Chalmas and *Cardita beaumonti* d'Archiac, species characteristic of the Maastrichtian of Tunis, and *Roundaireia d'rui*, a species common in the Campanian and Maastrichtian.

Douvillé (1931) described eight species of ammonites collected at Salinas (see Fig. 1), to which he assigned a Barremian to Turonian age. Spath (1931, 1932, 1951), in reviews of Douvillé's paper, showed the fauna to be of Cenomanian age, an age supported by the fact that the entire fauna '... had all been collected in a bed of only 4 m in thickness' (Spath 1951: 123).

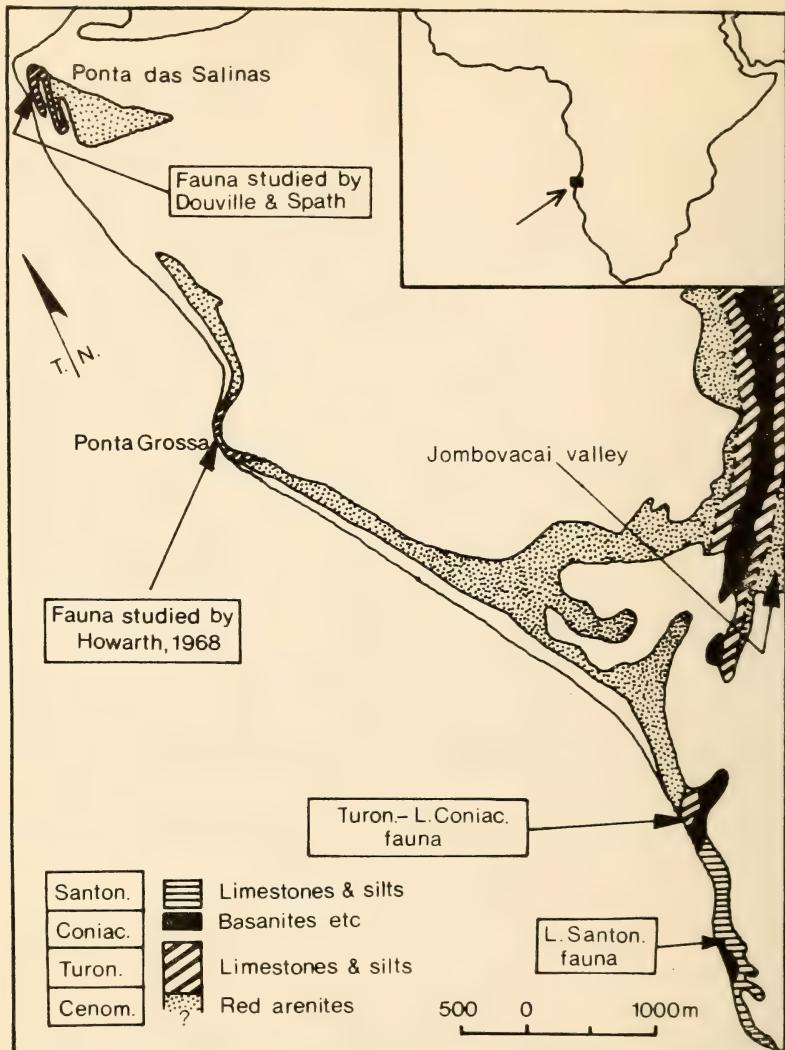


FIG. 1. Locality map (after Carvalho 1961).

Mouta & O'Donnell (1933) and Mouta (1937) studied the Cretaceous of the Moçâmedes and Benguela basins and considered the Senonian to be represented by the strata with *Roundaireia forbesiana* and *R. drui* at San Nicolau, and by the ammonites of Salinas. At San Nicolau, Mouta & O'Donnell (1933) considered the Senonian to be represented by two horizons, the Coniacian and Maastrichtian, separated by a basaltic layer and characterized by *R. forbesiana* and *R. drui* respectively.

Rennie (1929, 1945) described collections of bivalves and gastropods from San Nicolau and Salinas. The presence of *Trigonoarca angolensis* Rennie and

Trigonocallista umzambiensis Woods at Salinas led Rennie to believe the beds to be of Campanian-Maastrichtian age. The San Nicolau fauna, with *Turritella (Zaria) bonei* Baily, *Trigonoarca* cf. *trichonopolytensis* (Forbes), *Trigonia (Scabrotrigonia) shepstonei* Griesbach, and *Lima (Mantellum)* sp., was correlated with the Baba fauna and also included within the Campanian-Maastrichtian.

Spath (1951) described *Eutrephoceras indicum* (Spengler) and *Baculites* aff. *asper* (Morton) from the beds overlying the basalt, placing them '... probably also very high in the Senonian'.

In 1958 Carvalho reviewed the problems associated with the Cretaceous formations of the Moçâmedes basin and envisaged the following depositional history:

During the Aptian-Albian a lagoonal basin was dominant over the region, slowly filling with sediments, only to be overlain by thick torrential deposits marking an epoch of regression and the proximity of high relief

Subsequently the Albian sea covered the north of the basin

During the Cenomanian and Turonian, the southern portion of the basin emerged, whilst marine deposits were accumulating in the northern portion

The Coniacian and Santonian was an epoch of emergence, during which the region fell under the influence of volcanic activity, with the eruption of the basalts

During the Campanian, there was a widespread transgression with the laying down of sediments on a peneplaned surface of Basement, early Cretaceous sediments and basalt

Within the southern region the sea regressed, whilst deposition continued in the north

The Maastrichtian saw a new phase of marine transgression, with the accumulation of deposits throughout the region

In 1961 Carvalho mapped the marine beds below the basalts at San Nicolau as Cenomanian-Turonian, and the overlying beds as Campanian, considering the basaltic rocks, comprising analcime tephrites and basanites, basalts and andesites (Andrade 1957: 742), as having occurred '... at the end of the Turonian or during the Coniacian-Santonian'.

Howarth (1968) described an ammonite fauna from Ponta Grossa, about 3 km to the south of Salinas, in beds underlying the volcanics, to which he assigned a Middle Turonian age.

Kennedy (1971), in referring to the faunas described by Douvillé and Spath, considered '... all but the "*Stoliczkaia*" and "*Pulchellia*" indicate a high Cenomanian or basal Turonian age. The *Stoliczkaia* is taken by Spath (1931) and Howarth (1965) to be of Cenomanian age, but must surely be Lower Cenomanian, whilst the "*Pulchellia*" seems a misidentified acanthoceratid (Spath 1931)'.

PRESENT INVESTIGATION

A recent examination of Douvillé's type locality at Salinas, together with exposures to the east of San Nicolau, has led to stratigraphical conclusions somewhat different from those proposed by previous authors.

At Salinas, and along the beach to the south of Ponta Grossa, at least 35 m of unfossiliferous red sands and silts are exposed in the sea-cliffs and are of pre-uppermost Cenomanian age. The first fossiliferous horizon is characterized by the gastropod *Pseudomelania salenasensis* Rennie, together with

abundant *Exogyra* cf. *columba* (Lamarck), *Protocardia hillana* (J. Sowerby), *Exogyra olisipinensis* Sharpe and *Venella forbesiana* (Stoliczka). It was from these beds that the collection described by Rennie (1945) as of Campanian-Maastrichtian age came. Unfortunately, ammonites are lacking. This horizon is succeeded, a few metres higher up, by about 6 m of silts with abundant nodular limestone horizons, the latter representing the source of Douville's fauna. These beds are characterized by the abundance of *Exogyra* cf. *columba*, together with the ammonites *Calycoceras naviculare* (Mantell), *Kanabiceras septemseriatum* (Cragin), *Austiniceras dibleyi* Spath and *Pseudocalycoceras angolaense* (Spath). Other ammonite genera include *Gaudryceras*, *Eucalycoceras*, *Protacanthoceras*, *Sciponoceras*, *Tetragonites*, *Metoicoceras* and '*Stoliczkaia*'. The proximity of the Turonian boundary, suspected by Kennedy (1971), is confirmed by a single, fragmentary specimen of *Gomeoceras*, found in surface scree.

The Salinas exposure, as exemplified by the faunas of Douvillé and Spath, is therefore of uppermost Cenomanian age, and is conformably succeeded by Turonian strata.

Exposures between those at Salinas and the coastal outcrop of the volcanics, 7 km to the south, are confined almost entirely to the Ponta Grossa locality of Howarth (1968) which, at the time of my visit, was unfortunately inaccessible. From this locality Howarth described a 'mid-Turonian' fauna comprising eight ammonites belonging to the following six species: *Anagaudryceras involvulum* (Stoliczka), *Gaudryceras varagurense* Kossmat, *Mesopuzosia yubarensis* (Jimbo), *Damesites ainuanus* Matsumoto, *Mammites mocamedensis* Howarth and *Prionocyclus carvalhoi* Howarth. The fact that *Mammites* is predominantly a Lower Turonian genus, while *Damesites ainuanus* is recorded from the Upper Turonian of Japan and *Prionocyclus carvalhoi* is closest to the Middle Turonian *P. hyatti* (Stanton), led Howarth to date the fauna '... with some certainty to be very close to the mid point of the Turonian'.

In the sea-cliffs 6 km due west of San Nicolau ($14^{\circ}15'S$, $12^{\circ}23'E$), and about 5 m below the volcanics, fossiliferous strata are well-exposed in a deep gully. This fauna is characterized by the abundance of *Venella forbesiana* (Stoliczka), together with *Prionocyclus carvalhoi*, *Mammites mocamedensis* and *Damesites ainuanus* and the ammonite genera *Proplacenticeras*, *Mesopuzosia*, *Subprionocyclus*, *?Subtissotia*, *Baculites*, *Gaudryceras*, *Scalarites*, *Kossmaticeras*, *Hauericeras* and *Hypophylloceras*. Of these additional specimens the placenticeratids and the *Mesopuzosia* sp. closely resemble forms common in the Lower Coniacian of Zululand, *Subprionocyclus* is characteristic of Upper Turonian strata, *Scalarites* is known from the Turonian and Coniacian of Morocco (Collignon 1966), the *Hauericeras* sp. is very close to *H. antiquum* Collignon (Collignon 1961: 76) from the Lower Coniacian of Madagascar, while *Subtissotia* is known from the Coniacian of Tunisia. The baculitids are, according to Dr W. A. Cobban (United States Geological Survey, Denver), who kindly examined them for me, closest to undescribed Upper Turonian forms from New Mexico.

Immediately below this fossiliferous horizon is a bed rich in stromatolites. This deposit has, therefore, all the features of a classical condensed sequence, as recorded by Rod (1946), Jenkyns (1971) and others, viz. faunal enrichment and faunal mixing, negligible thickness and widespread distribution, and associated stromatolitic algae. Sedimentological evidence supports this, since in the coastal cliffs west of San Nicolau about 25 m of limestones and silts are seen to separate the volcanics from the unfossiliferous red sands, whereas the measured section in the gully totalled 14 m, while the Upper Cenomanian at Salinas was at least another 8 m. Howarth's fauna is, without question, from the same horizon which must be considered a condensed sequence spanning Turonian to lowest Coniacian times.

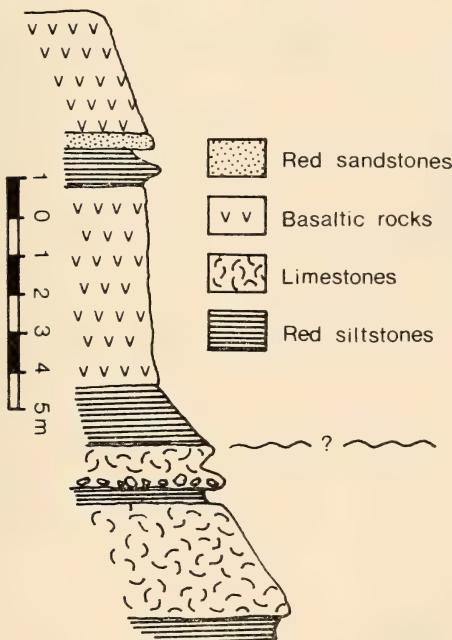


FIG. 2. Geological section through the west side of the Jombovacai valley, about 2 km north of the Posto de San Nicolau (for explanation see text).

Deposition of this stratum was followed by a period of emergence and the eruption of the alkali-basalts. The presence of a disconformity between these beds and the basalts is evident in the section exposed in the western side of the Jombovacai valley (see Fig. 2) about 2 km north of the Posto de San Nicolau. Here, 3 m of highly fossiliferous white limestone, unfortunately lacking in ammonites, are crammed with bivalves and gastropods with their recrystallized shells preserved. These are overlain by 0.28 m of unfossiliferous maroon silts succeeded by 1.05 m of hard red limestone, unlike any exposed in the coastal

section, in which the fossils are preserved only as internal moulds. At the base of this horizon is a thin, small-pebble conglomerate. This red limestone horizon is separated from the basanites by 1,54 m of unfossiliferous red silts.

The completely different mode of preservation of the fauna within this latter limestone, together with its red colour, suggests the disconformity to lie immediately above this horizon. The absence of pillow structures within the lavas also testifies to their subaerial extrusion. In the Jombovacai valley at least two distinct phases of lava extrusion are indicated by the occurrence of 1,33 m of interbedded red silts and sandstones.

During early Santonian times a widespread transgression resulted in the deposition of marine beds on the newly laid down volcanics. That these beds are, at their base, Lower Santonian is indicated by the occurrence of the ammonite genera *Texanites*, *Protexanites*, *Hauericeras* and *Damesites*. This fauna occurs in orange limestones characterized by the abundance of *Cardium (Trachycardium) reynoldsi* Rennie.

The volcanics are, therefore, restricted to the Coniacian, probably only the Upper Coniacian, and are consequently of much more limited duration than previously thought.

With the exception of pyritized (now limonitic) worm burrows, fossils are absent from the succeeding green silts until the occurrence of abundant vertebrate remains and shark's teeth about 20 m higher up. The most abundant fossils are *Anacorax pristodontus* (Agassiz), together with *Lamna biauriculata* Wanner, *Rhombodus binkhorsti* Dames, *Enchodus* sp. and *Mosasaurus beaugei* Arambourg. On purely sedimentological evidence it seems unlikely that these beds are indeed Maastrichtian, as suggested by Darteville (1942) from a study of the shark's teeth, since most of the Santonian and the entire Campanian would have to be accommodated within 20 m of sediment. Furthermore, there is no sign of the rich uppermost Campanian fauna of Egito, nor the Maastrichtian faunas of the Cuanza basin.

SUMMARY

At Salinas red arenites are overlain by limestones containing *Calycoceras naviculare*, *Kanabiceras septemseriatum* and *Austiniceras dibleyi*, species characteristic of the *Sciponoceras gracile*—*Metoicoceras whitei* zone of North America. The absence of *Mammites*, present in higher beds to the south, suggests these beds to be of uppermost Cenomanian rather than basal Turonian age, although a single specimen of *Gomeoceras* collected in surface scree indicates the proximity of the latter stage. There is no evidence for Upper Albion or Lower Cenomanian strata at Salinas. These beds are conformably overlain by the Turonian, represented by a condensed sequence as evidenced by the enriched and mixed faunal assemblage, and the diminutive stratal thickness, with an admixture of basal Coniacian forms. Deposition of these strata was followed by a period of emergence and the eruption of the alkali-basalts, probably during Upper Coniacian times. Following this period of volcanic extrusion, a marine trans-

gression deposited limestones with *Protexanites* and abundant *Texanites*, and thus of Lower Santonian age. About 30 m above this horizon are beds with abundant vertebrate remains and shark's teeth. On purely sedimentological evidence their Maastrichtian assignment is considered dubious.

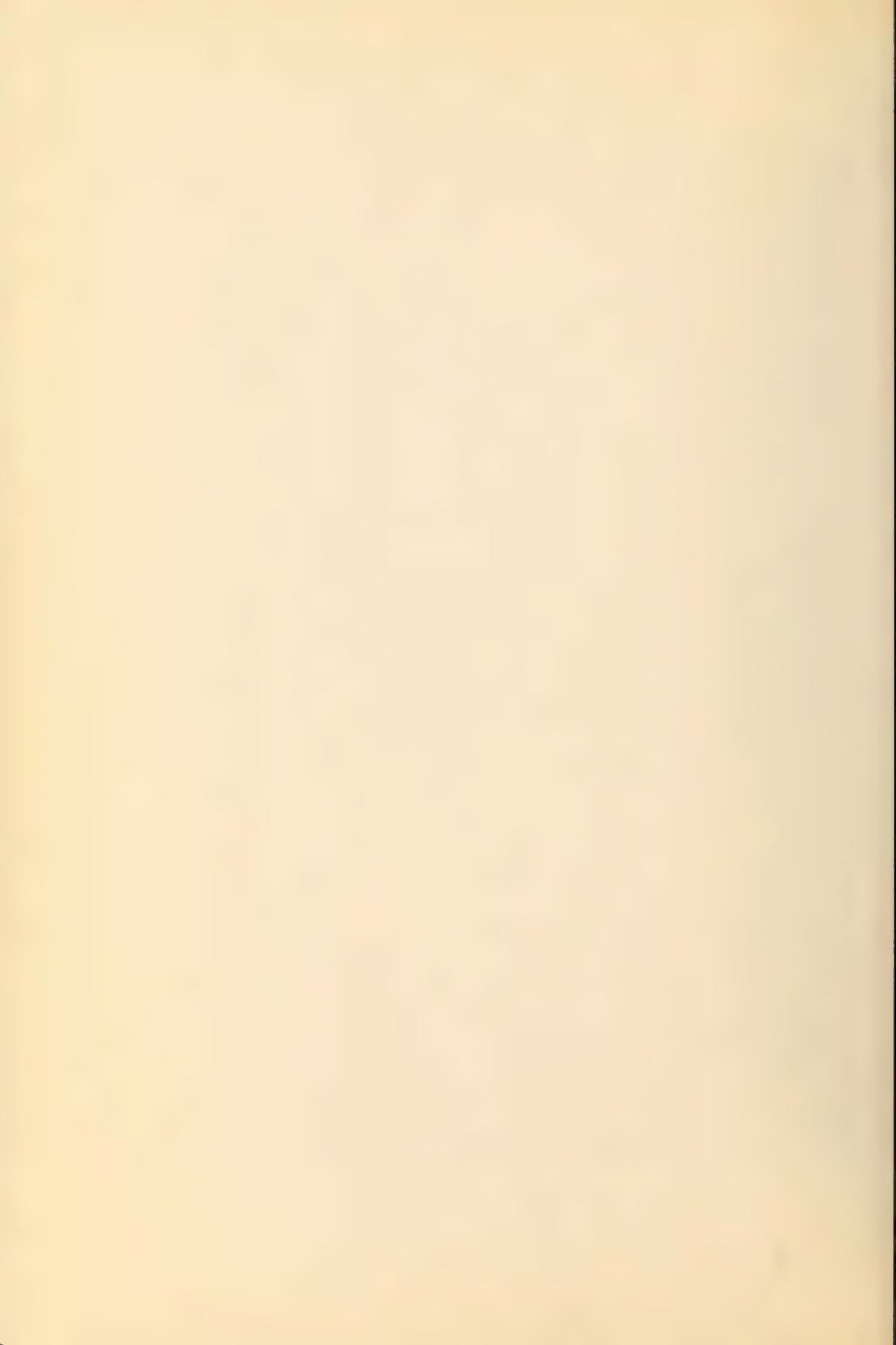
ACKNOWLEDGEMENTS

I should like to express my thanks to Professor Virgilio Cannas Martins, director of the Instituto de Investigaçāo Científica de Angola, for the assistance given me by his institute, without which this study would have been impossible. I should also like to express my thanks to Mr Joaquim Torquato of the same institute for his help and assistance. To Dr António Graca da Cruz, Director of the Serviços de Geologia e Minas, I am indebted for his co-operation and kindness.

I am especially grateful to Dr W. J. Kennedy of Oxford University for his kind help and valuable suggestions.

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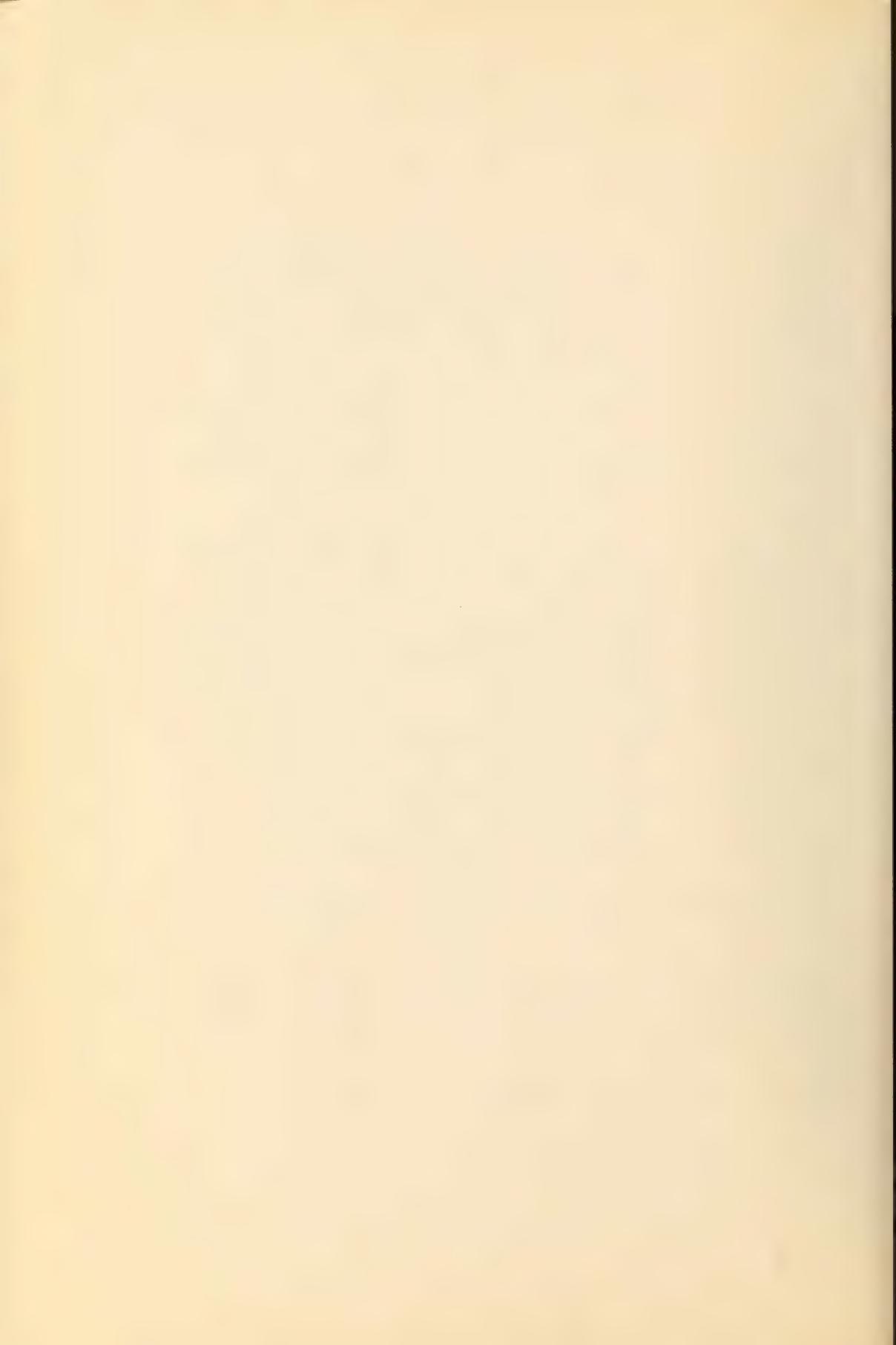
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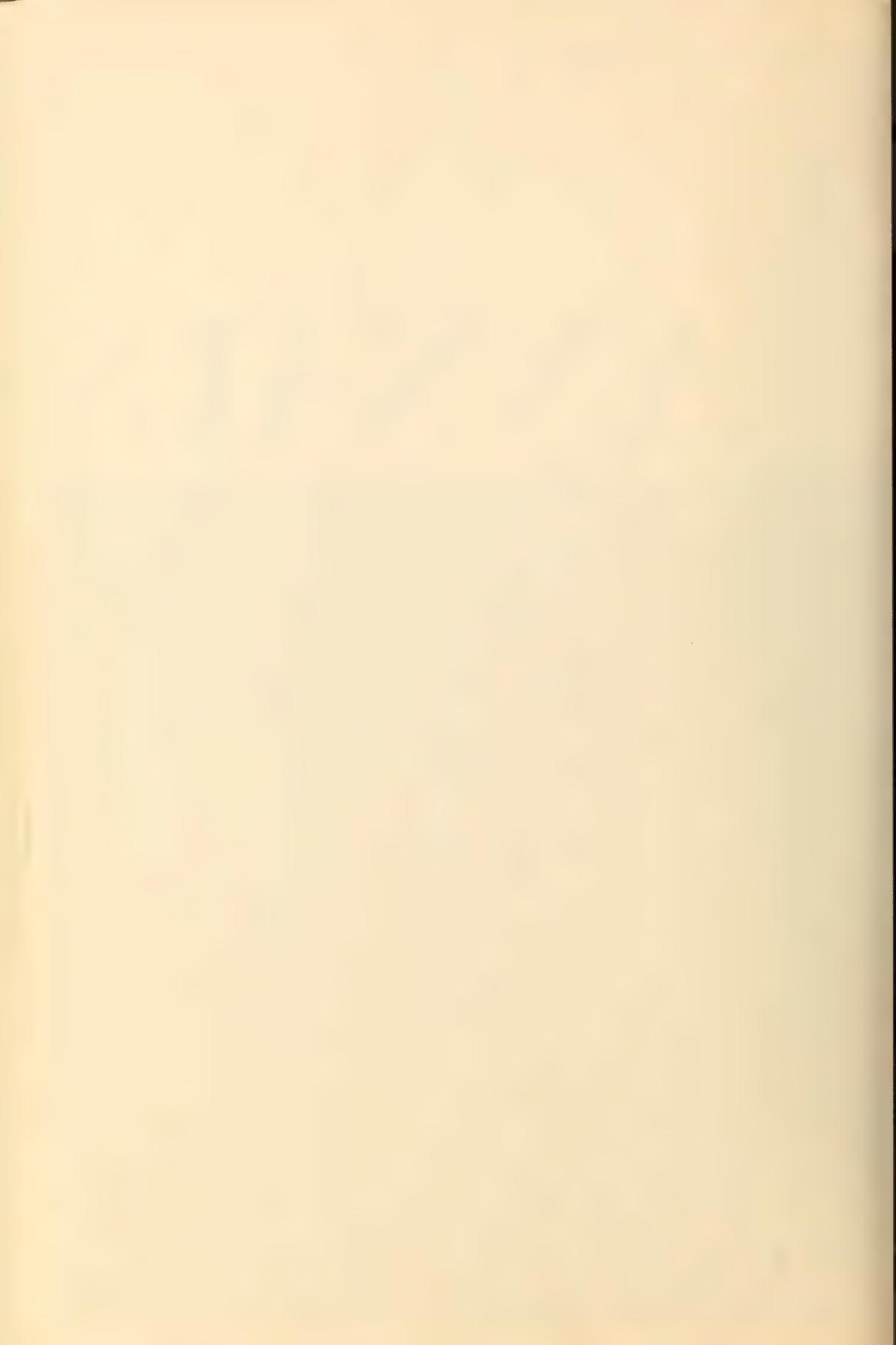
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ANNALS OF THE SOUTH AFRICAN MUSEUM

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A NEW SPECIES OF SOUTHERN AFRICAN
BREVIRAJID SKATE
(CHONDRICHTHYES, BATOIDAE RAJIDAE)

By
P. A. HULLEY

Cape Town Kaapstad

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1, 2(1, 3, 5, 7-8), 3(1-2, 5, t.-p.i.), 5(1-2, 5, 7-9),
6(1, t.-p.i.), 7(1-3), 8, 9(1-2), 10(1),
11(1-2, 5, 7, t.-p.i.), 24(2), 27, 31(1-3), 33

Price of this part/Prys van hierdie deel
R1,90

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1972

ISBN 0 949940 24 0

Printed in South Africa by
The Rustica Press, Pty., Ltd,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

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By

P. A. HULLEY

South African Museum, Cape Town

(With 5 figures and 1 table)

[MS. accepted 3 July 1972]

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INTRODUCTION

In his revision of the southern African Rajidae, Norman (1935) held that the two spinulose juveniles, reported as *Raja plutonia* Garman by Barnard (1925), were specimens of *Raja spinacidermis*, since their dorsal surfaces were entirely covered with small asperities and the enlarged thorns along the midline of the back and tail showed signs of disappearance. Although these specimens were not available to him, Hulley (1970), on the basis of two further specimens (SAM 22911, 24450), tentatively accepted Norman's synonymy. However, he pointed out that, not only are there differences between these specimens and *Raja spinacidermis* in the spination of the orbital region, the shape of the disc and the tail length, but also there were marked differences in the tooth count (36–38 rows in the upper jaw, compared with 54–60 rows in *Raja spinacidermis*).

The Division of Sea Fisheries, Cape Town, has recently collected 15 specimens of these spinulose rajids, during the 1972 Hake Survey, and have donated this material to the South African Museum. Examination of the rostral cartilage and appendices and of the anatomy of the clasper of these specimens reveals that they should be described as a new species, *Breviraja stehmanni*, and as such represent the first record of the genus outside the waters of the western central Atlantic. SAM 24450 can be identified as this species.

The genus *Breviraja* Bigelow & Schroeder, 1948, was constructed to incorporate those rajids having 'the tip of the rostral cartilage falling short of the extremities of the pectoral rays and of tip of snout', diagnostic characters which were based on X-ray photographs. However, Ishiyama & Hubbs (1968) point out that the interpretation of these photographs is erroneous, and that the rostral cartilage is not foreshortened and extends virtually to the tip of the snout, beyond the anterior tips of the pectoral rays. On the basis of the rostral structure and the anatomy of the clasper, Ishiyama & Hubbs (1968) substan-

tiate the validity of *Breviraja* and defined a further genus, *Bathyraja*, confining it to the Pacific. Stehmann (1970) and Hulley (1970, 1972) agree with these findings, but point out that the genus *Bathyraja* also exhibits a discontinuous, antitropical distribution pattern in the Atlantic, while the genus *Breviraja* appears to be confined to slope regions of the western central Atlantic. Furthermore, both Stehmann (1970) and Hulley (1972) have commented on the phylogenetic position of *Breviraja*.

Breviraja stehmanni is separated from all other southern African rajids by the peculiar form of the rostral cartilage and rostral appendices, and is at present the only species of this genus recorded from the region. It may easily be distinguished from all other species of the genus, except *B. plutonia* (Garman) and *B. cubensis* Bigelow & Schroeder, by its long, cross-barred tail and dark dorsal fins. It most closely resembles *B. plutonia* in that the dorsal fins are continuous, but differs markedly from this species in tooth count, length of the anterior lobe of the pelvic fin and number of scapular thorns. In these characters it approximates *B. cubensis*, but may be distinguished from this species by its continuous dorsal fins. Furthermore, *B. stehmanni* differs from both these species in its comparatively larger disc, shorter tail, smaller eye and shorter anterior pelvic lobe, and especially in the presence of a single, median row of larger thorns on the back and tail, which extends to about one-half to two-thirds the length of the tail.

The species is named in honour of Dr M. Stehmann, Institut für Seefischerei, Hamburg.

DESCRIPTION OF MATERIAL

Breviraja stehmanni n. sp.

Raja plutonia: Barnard, 1925: 68.

Raja spinacidermis: Norman, 1935: 46 (*partim*).

?*Raja spinacidermis*: Hulley, 1970: 173, pl. 4, fig. A.

Types

The type, an adult male (354,3 mm total length) and paratype, a female (299,5 mm total length), trawled between 33°53,7'S, 17°23,9'E and 33°57,3'S, 17°22,2'E in 640 m (Division of Sea Fisheries, Station No. A 5854), in the collection of the South African Museum (SAM 26636, 26637).

Material

The type and paratype, and 13 specimens of both sexes (132,5–340,0 mm total length) trawled from two stations, A 5854 (10 April 1972: 33°53,7'S, 17°23,9'E–33°57,3'S, 17°22,2'E; 640 m; bottom temp. 5,55°C) and A 5871 (33°55,6'S, 17°25,0'E–33°56,1'S, 17°26,8'E; 600 m; bottom temp. 5,70°C), and 1 specimen, a female (305 mm total length), trawled west of Cape Town in 160 fms (292 m). All specimens in the collection of South African Museum (SAM 24450, 26638, 26639).



B



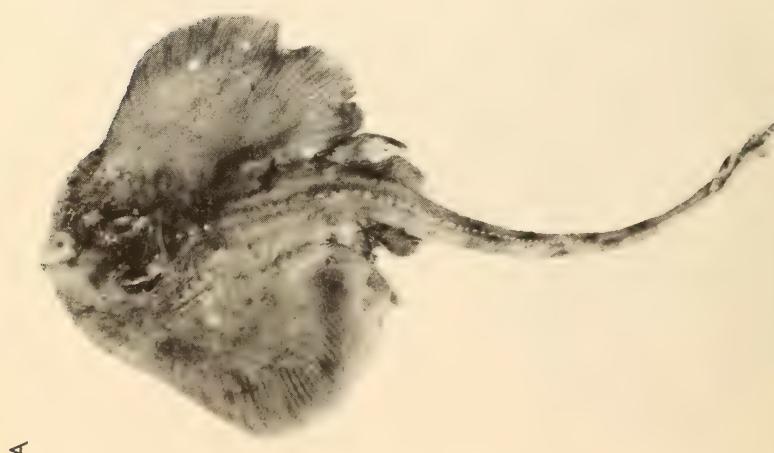
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FIG. 1
Brevikaja stehmanni n. sp. TYPE. A. Dorsal view. B. Ventral view. Scale in cm and in.



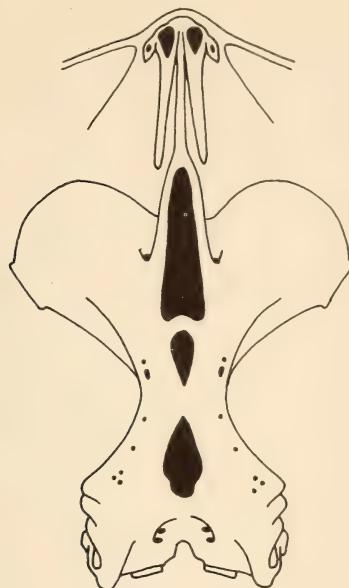
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FIG. 2.
Breviraja stehmanni n. sp. PARATYPE. A. DORSAL VIEW. B. VENTRAL VIEW. SCALE IN CM AND IN.



1.0 cm
—

FIG. 3.

Breviraja stehmanni n. sp. Neurocranium, rostral bar and appendices, and anterior extremities of pectoral rays.

Description

Measurements for the type and paratype, respectively, are given, while the figures in parentheses refer to the range of variation for 14 specimens.

Disc, 1,3; 1,2 (1,2–1,4) times as broad as long, its width 1,8; 1,9 (1,7–1,9) in total length; obtuse in front, tip of snout marked by a low projection, with maximum angle in front of spiracles 123°; 129° (115°–130°); anterior margins slightly concave just behind tip of snout and again at level of spiracles, more strongly so in adult males than in females and juveniles; outer angles broadly rounded, posterior and inner margins strongly convex. Axis of greatest breadth 1,4; 1,5 (1,3–1,7) times as far from tip of snout as from posterior edge of disc. Tail with narrow lateral folds along posterior third; its length from middle of vent to origin of first dorsal fin 1,2; 1,3 (1,1–1,3) times as long as distance from middle of vent to tip of snout.

Entire upper surface of disc and tail with small asperities, except tip of snout, narrow anterior margin of pectoral and anterior lobe of pelvic, and mature males with naked area at pectoral base. Orbit with 4–5 (1–6) thorns at anterior margin, well separated from 3 (1–4) thorns on posterior margin and above spiracle; 1 very small interspiracular thorn on each side in some juveniles;

TABLE I
Measurements expressed as permillage of the total length.

	<i>Type</i>	<i>Paratype</i>	<i>Range</i>	<i>Mean</i>
Total length	1000	1000		
Disc width	569	537	540-584	563
Disc length	444	437	423-471	456
Snout to greatest disc width	261	261	265-300	279
Snout to middle of vent	403	340	393-414	402
Snout to axils of pelvics	352	410	338-365	352
Middle of vent to 1st dorsal origin	488	456	470-498	486
Snout length	93	94	89-115	104
Preoral length	93	99	89-120	108
Prenasal length	68	71	66-88	79
Eye-horizontal diameter	32	30	28-36	30
Eye + spiracle	45	47	45-56	48
Spiracle	29	27	21-36	28
Interorbital distance	31	30	30-37	33
Interspiracular distance	67	72	67-75	71
Internasal distance	62	60	59-66	63
Mouth width	79	73	69-90	76
Gill slit lengths: 1st	11	16	11-14	13
3rd	12	16	11-16	14
5th	11	10	9-13	11
Distance between inner ends of gill slits: 1st	129	131	121-141	131
5th	69	79	67-90	77
1st dorsal fin: height	31	28	16-31	26
base length	54	56	44-53	49
2nd dorsal fin: height	21	33	16-34	28
base length	55	56	43-56	50
Interdorsal space	0	0		0

3-4 (1-4) median nuchal thorns; 1 scapular thorn (sometimes lost, but scar present) on each side; a series of 26-39 (11-38) thorns along midline of back and tail, usually interrupted between pectoral and pelvic girdles, extending posteriorly to between one-half and two-thirds the length of the tail, showing alternate development with increasing age; tail posterior to axis of pelvics without additional rows of thorns or large prickles; anterior parts of dorsal fins with small asperities. Sexually mature males with well-developed malar and alar spines. Ventral surface smooth.

Snout rounded and barely produced, except somewhat so in adult males; its length in front of orbits 3.0; 3.1 (2.9-3.8) times as long as distance between orbits; its length in front of mouth 1.5; 1.6 (1.5-1.9) times as great as distance between nostrils. Orbit 1.0; 1.0 (0.8-1.0) as long as distance between orbits and 1.1; 1.1 (0.8-1.4) times as long as spiracle. Spiracle extending to below middle of eye.

Neurocranium typically guitar-shaped and markedly constricted across orbital region, with well-developed postorbital processes and poorly developed jugal arches; nasal capsules directed obliquely forward to about 40° to median axis, without ethmoidal nerve foramen; rostral cartilage projecting from cranium to tip of snout as a thin, delicate rod, without a segment; rostral appendices narrowly attached to extremity of rostral bar and extending pos-

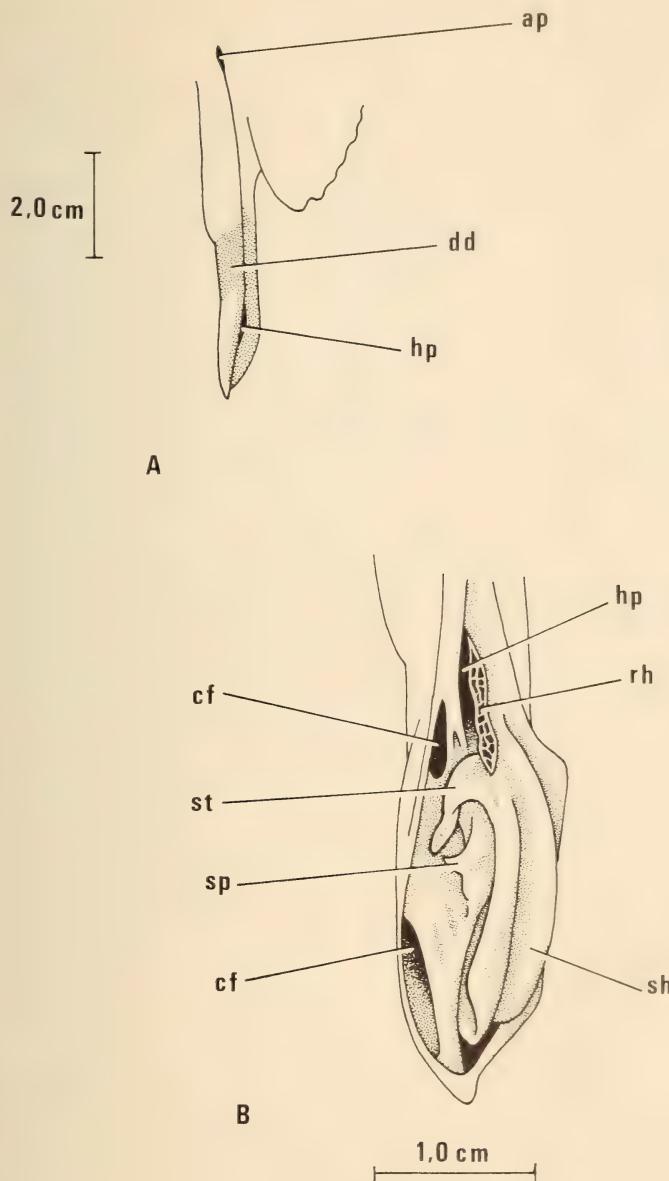


FIG. 4.

Breviraja stehmanni n. sp. A. External view of right clasper from the dorsal side. B. Lateral view of right clasper, opened to show structural features of the glans.
 ap—apopyle; cf—cleft; dd—dermal denticles; hp—hypopyle; rh—rhipidion; sh—shield;
 sp—spike; st—sentinel.

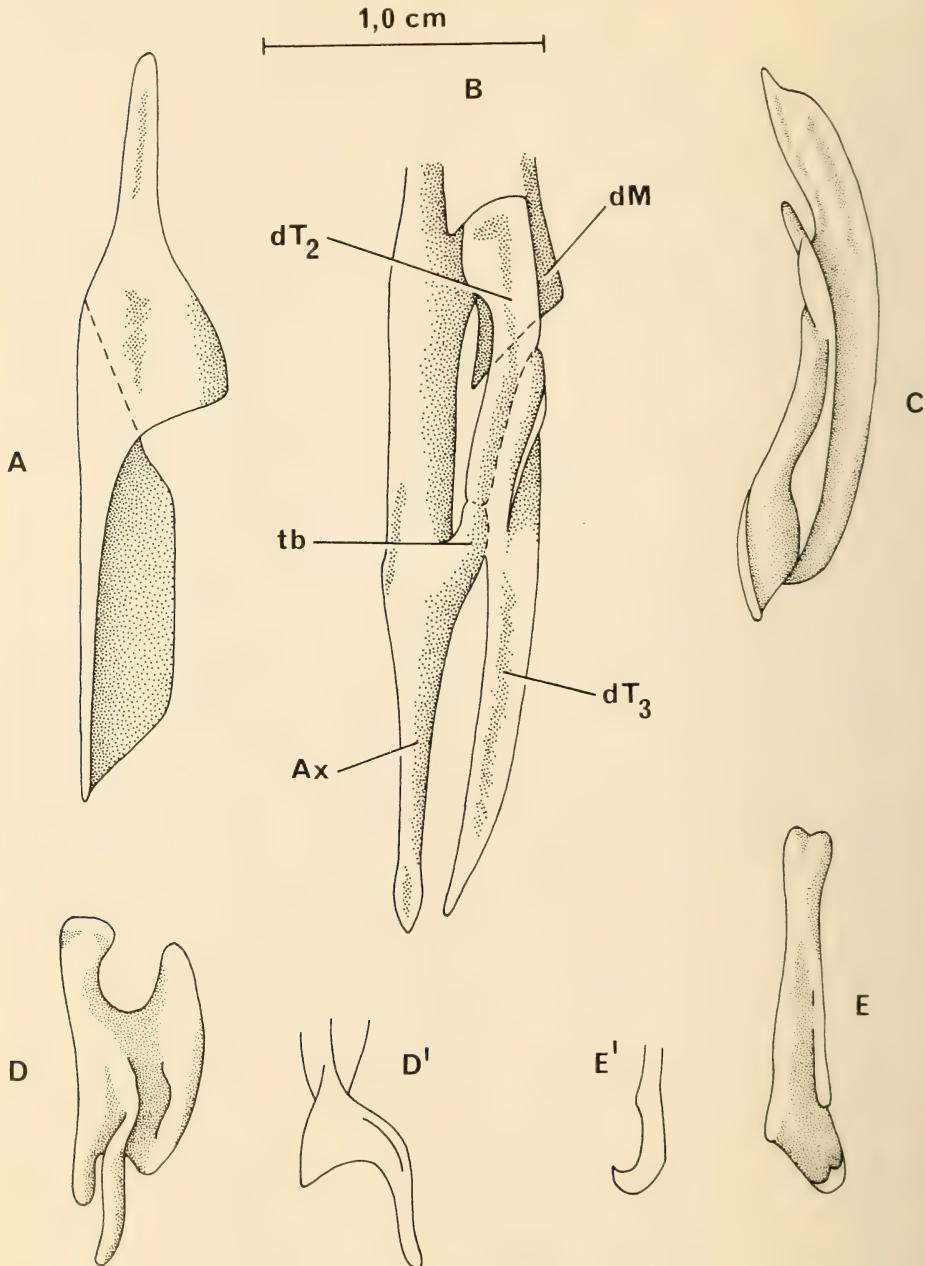


FIG. 5.

Breviraja stehmanni n. sp. Clasper cartilages. A. Dorsal terminal 1 (dorsal view). B. Axial, dorsal marginal, dorsal terminal 2 and 3, and terminal bridge (dorsal view). C. Ventral terminal (dorsal view). D. D'. Accessory terminal 1 (dorsal and lateral views). E. E'. Accessory terminal 2 (dorsal and lateral views).

Ax—axial; *dM*—dorsal marginal; *dT₂*, *dT₃*—dorsal terminals 2 and 3; *tb*—terminal bridge.

teriorly to level of anterior fontanelle, well separated from rostral bar; anterior notch bridged with a thin cartilaginous connection; small additional appendix on each side, with a foramen; radial cartilages of pectorals extending anteriorly almost to appendices; anterior fontanelle well developed, with anteriorly arched epiphysial bridge; 2 (sometimes 1) posterior fontanelles; orbito-nasal canal foramen comparatively small, anterior cerebral vein foramen above level of optic foramen.

Mouth weakly arched medially; nasal curtain fringed. Teeth arranged in 41, 39 (38–44) rows in upper jaw, blunt and flat and in quincunx in females and juveniles, but adult males with laterally directed, long, conical points in centre of jaw.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin; anterior margin of pelvic about 70%, 78% (68–84%) as long as distance from its own origin to rear tip of pelvic.

Dorsal fins similar in shape and about similar in size, confluent at base; caudal membrane posterior to second dorsal about half as long as base of second dorsal.

Vertebral count: Vtr 26; 26 (24–26); Vprd 69; 71 (65–74); VΣ 95; 97 (91–98).

Claspers pointed; pseudosiphon absent; dermal denticles present on dorsal border and ventral surface; inner dorsal lobe with two clefts separated by terminal bridge; rhipidion fan-shaped and situated at hypopyle; shield well-developed; laterally projecting sentinel and recurved spike situated medially. Axial cartilage pointed terminally; dorsal marginal with short distal extension, ventral marginal distally arched; dorsal terminal 1 cartilage with proximal extension; dorsal terminal 2 and 3 cartilages simple and forming dorsal lobe framework; ventral terminal cartilage with dorsally convex, outer, lateral margin and with anterior notch at about one-third the length of the cartilage from the proximal end; accessory terminal 1 cartilage U-shaped proximally and with well developed Z-shaped lateral projection; accessory terminal 2 simple, with hooked, spatula-like distal extremity, closely attached to axial cartilage along its inner lateral margin.

Colour

Upper surface of disc greyish, skin at bases of prickles and at rear sides of larger thorns not especially pigmented; disc with irregular darker blotches and scattered paler spots; tail with 6–7 irregular, dark crossbars, either continuous across dorsal surface or interrupted, the two most posterior crossbars nearly black and passing through first and second dorsal fins. Lower surface of disc pale but tip of snout with black spot; thin darker areas along anterior margin of pectoral, wider along posterior margins and margins of pelvics; dusky, irregular areas sometimes between nostrils, around mouth, between gills and on belly; tail with dark crossbars encroaching from sides of tail, but mature specimens with ventral surface of tail somewhat darker mottled in a few cases.

Size

Males mature at about a length of 340 mm, as ascertained from the degree of calcification of the clasper cartilages and the presence of well developed malar and alar spines. Females probably reach a slightly greater size at sexual maturity.

Distribution

South of Agulhas Bank to west of Cape Town in 292-1 025 metres.

DISCUSSION

As has been pointed out, the genus *Breviraja* was previously thought to be confined to the edges of the continental shelf and upper regions of the slope in the western central Atlantic (Bigelow & Schroeder 1953; Stehmann 1970; Hulley 1972) in depths of 200-727 fms (366-1 329 m). *Breviraja stehmanni*, which is so far known only from the eastern South Atlantic, west of Cape Town, appears to have a similar depth distribution, 160-560 fms (292-1 025 m). Bottom temperatures at this depth and in this region may vary between 3°C and 8°C (Hulley 1972). The species may be more widely distributed in the southern African region and may not be confined only to the Atlantic, since bottom temperatures are more or less uniform at depths greater than 100 m, both east and west of Cape Point. Hulley (1972) has pointed out that the majority of species are widely distributed throughout the entire southern African region.

An association of *Breviraja* with the *Dipturus*-line of evolution (Hulley 1972) appears to be substantiated by the anatomy of the claspers and neurocranium of *Breviraja stehmanni*. The dorsal position of the foramen of the anterior cerebral vein and the general arrangement of the clasper, especially the well developed rhipidion, lack of a proximal shelf on the dT₁ and well developed vT, suggest an association with the *Dipturus/Amblyraja/Leucoraja/Rajella*-line rather than with the *Bathyraja/Raja/Rostroraja*-line (Hulley 1972: fig. 56).

Breviraja might be considered to be ancestral to both the *Dipturus*- and the *Amblyraja/Leucoraja/Rajella*-lines of evolution, since the predorsal caudal vertebral count is high and the clasper exhibits primitive characteristics in the retention of dermal denticles, a pointed distal tip to the Ax cartilage and the well developed Z-shaped lateral projection of aT₁ (Fig. 5; Ishiyama & Hubbs 1968: fig. 2). However, the lack of an external pseudosiphon, arrangement of the dT₂ and dT₃ cartilages and the more proximal position of the anterior notch on the vT, point to a closer association with the *Dipturus*-line. The development of a thin rostral bar, without anterior grooving, and of the characteristic rostral appendages, indicate a specialized condition for the genus. It may therefore be concluded that the genus *Breviraja* represents a very early split from the *Dipturus*-line, which penetrated somewhat deeper regions and retained the neotonous condition of the snout as an increased advantage in grubbing.

SUMMARY

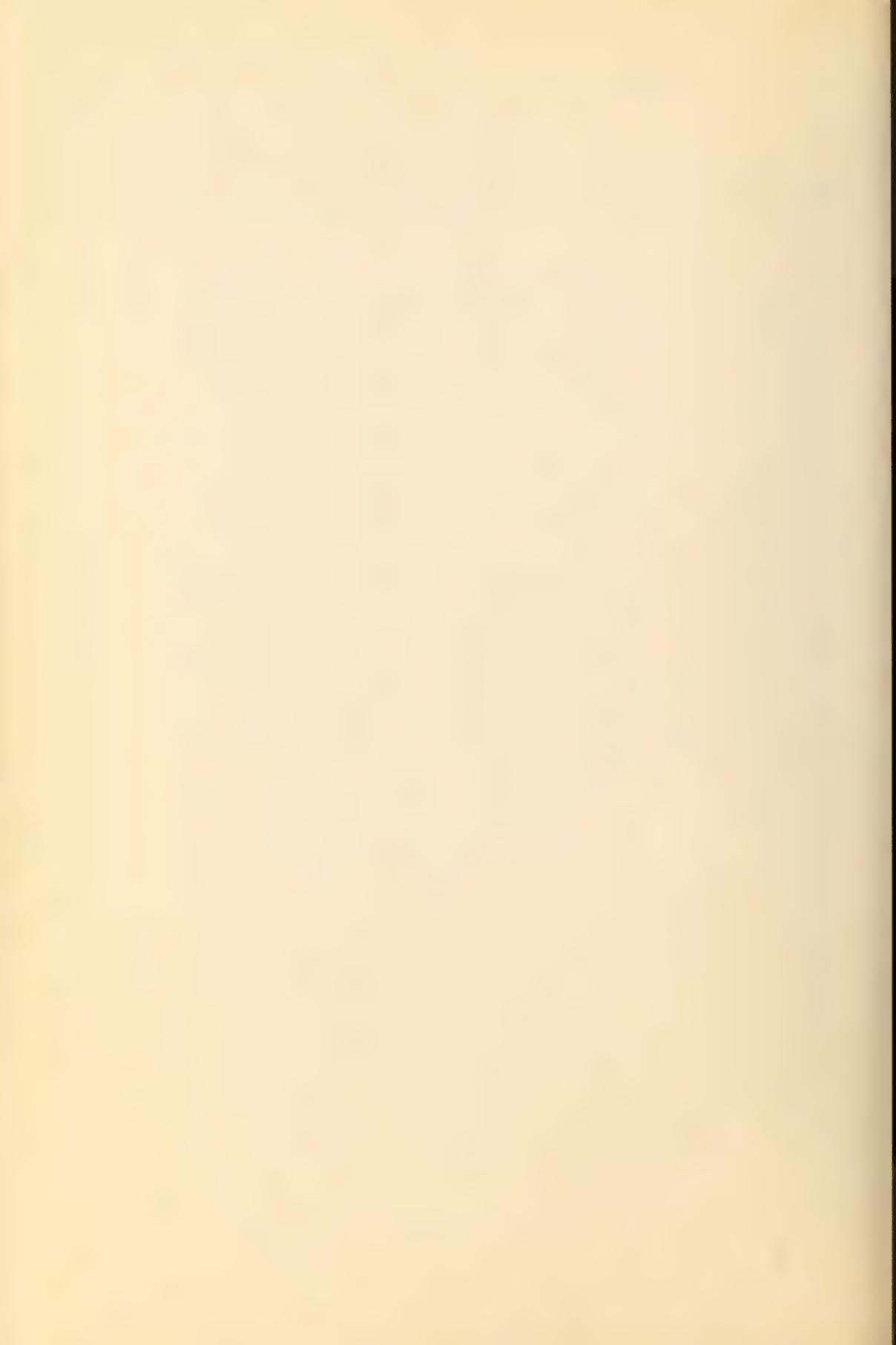
A new species of southern African skate, *Breviraja stehmanni*, is described and represents the first record of the genus outside the waters of the western central Atlantic. The phylogenetic position of *Breviraja* is briefly discussed.

ACKNOWLEDGEMENTS

I am deeply indebted to the Director and Staff of the Division of Sea Fisheries, Cape Town, for the collection and donation of the rajid material, and especially to Mr L. Botha and Mr D. Chalmers of that Institute. I should also like to thank Mr S. X. Kannemeyer, of the South African Museum, for his assistance with the X-ray photography.

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(4) Summary.
(5) Acknowledgements.
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World list of scientific periodicals. 4th ed. London: Butterworths, 1963), series in parentheses, volume number, part number (only if independently paged) in parentheses, pagination.

Examples (note capitalization and punctuation)

BULLOUGH, W. S. 1960. *Practical invertebrate anatomy.* 2nd ed. London: Macmillan.

FISCHER, P.-H. 1948. Données sur la résistance et de la vitalité des mollusques. *J. Conch., Paris* **88**: 100–140.

FISCHER, P.-H., DUVAL, M. & RAFFY, A. 1933. Etudes sur les échanges respiratoires des littorines. *Archs Zool. exp. gén.* **74**: 627–634.

KOHN, A. J. 1960a. Ecological notes on *Conus* (Mollusca: Gastropoda) in the Trincomalee region of Ceylon. *Ann. Mag. nat. Hist.* (13) **2**: 309–320.

KOHN, A. J. 1960b. Spawning behaviour, egg masses and larval development in *Conus* from the Indian Ocean. *Bull. Bingham oceanogr. Coll.* **17** (4): 1–51.

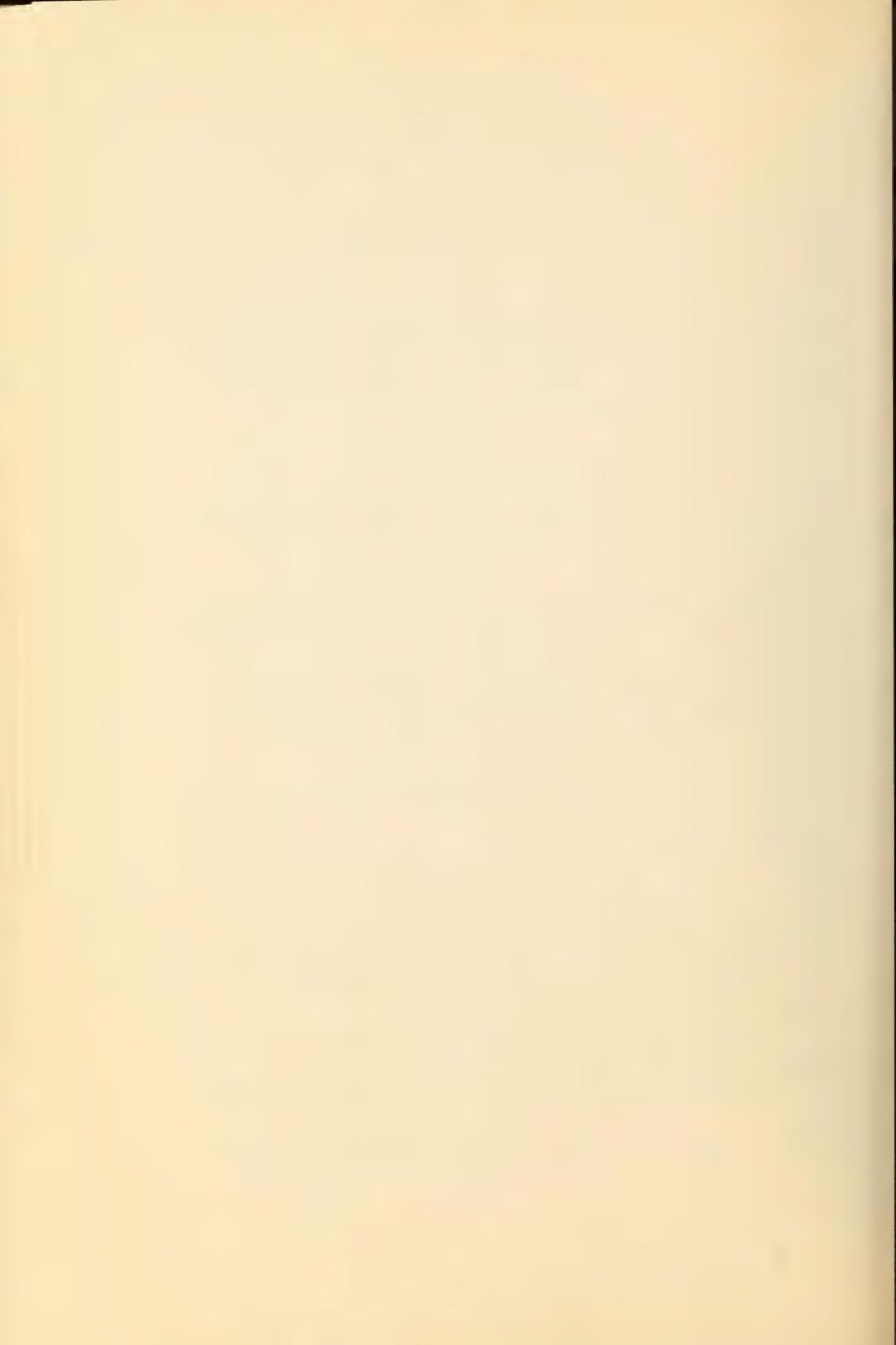
THIELE, J. 1910. Mollusca: B. Polyplacophora, Gastropoda marina, Bivalvia. In SCHULTZE, L. *Zoologische und anthropologische Ergebnisse einer Forschungsreise im westlichen und zentralen Süd-Afrika.* **4**: 269–270. Jena: Fischer. *Denkschr. med.-naturw. Ges. Jena* **16**: 269–270.

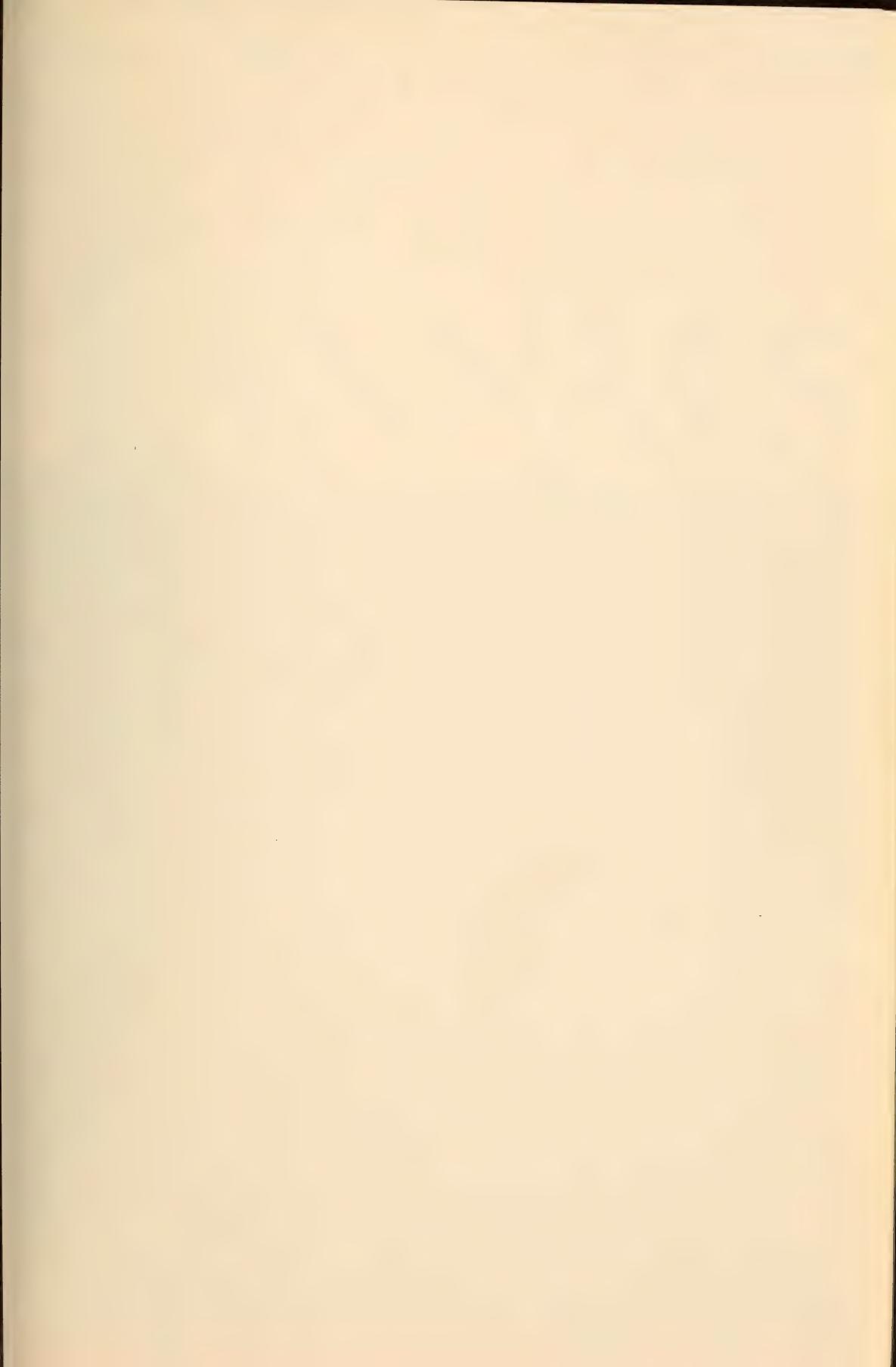
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Example

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P. A. Hulley

A NEW SPECIES OF SOUTHERN AFRICAN
BREVIRAJID SKATE
(CHONDRICHTHYES, BATOIDAE)

501.68

VOLUME 60 PART 10 APRIL 1973

ANNALS OF THE SOUTH AFRICAN MUSEUM

CAPE TOWN





ANNALS OF THE SOUTH AFRICAN MUSEUM
ANNALE VAN DIE SUID-AFRIKAANSE MUSEUM

Volume **60** Band
April **1973** April
Part **10** Deel



THE AMPHIPODA OF SOUTHERN AFRICA
PART I
THE GAMMARIDEA AND CAPRELLIDEA OF
SOUTHERN MOÇAMBIQUE

By
C. L. GRIFFITHS

Cape Town Kaapstad

The ANNALS OF THE SOUTH AFRICAN MUSEUM

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Die ANNALE VAN DIE SUID-AFRIKAANSE MUSEUM

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1, 2(1, 3, 5, 7-8), 3(1-2, 5, t.-p.i.), 5(1-2, 5, 7-9),
6(1, t.-p.i.), 7(1-3), 8, 9(1-2), 10(1),
11(1-2), 5, 7, t.-p.i., 24(2), 27, 31(1-3), 33

Price of this part/Prys van hierdie deel
R4,50

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1973

ISBN 0 949940 26 7

Printed in South Africa by
The Rustica Press, Pty., Ltd,
Court Road, Wynberg, Cape

In Suid-Afrika gedruk deur
Die Rustica-pers, Edms., Bpk.
Courtweg, Wynberg, Kaap

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PART I

THE GAMMARIDEA AND CAPRELLIDEA OF SOUTHERN
MOÇAMBIQUE

By
C. L. GRIFFITHS

C.S.I.R. Oceanographic Research Unit, Zoology Department, University of Cape Town
(With 11 figures)

[MS. accepted 15 August 1972]

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INTRODUCTION

The first comprehensive works on the Crustacea of southern Africa were those of T. R. R. Stebbing, culminating in his 'General catalogue of South African Crustacea' in 1910, which was largely based on the extensive collections of the S.S. *Pieter Faure*. K. H. Barnard continued to analyse the *Pieter Faure* material and in 1916 published descriptions of many new species and records, to be augmented in 1925 by a report on the last portion of the collection, bringing the total number of recorded species to 207. Barnard went on to publish more descriptions and a key to known species in 1940, and further additions to the fauna were forthcoming in 1951, 1955 and 1957.

Despite this excellent background, South African Amphipoda have subsequently been almost completely neglected, although collecting has continued unabated and many new records and undescribed species have undoubtedly accumulated, especially in the extensive collection of the University of Cape Town Ecological Survey.

It is in the light of these new data and of recent extensive taxonomic revisions that the decision has been made to synthesize existing knowledge of the South African amphipod fauna.

Mr Roy Dick has recently (1970) produced a key to, and distribution list of the Hyperiidea of southern Africa and it is the aim of the present work, and subsequent ones of a series, to cover the Gammaridea and Caprellidea of the same area (Africa south of 20°S) on a regional basis.

Moçambique has been selected as the subject of the first paper, since no previous literature specifically on the amphipods of this area appears to exist, although a checklist and key to the species of Inhaca Island (Macnae & Kalk 1958), descriptions of new species from Morrumbene estuary (Barnard 1916, 1955) and a key to common species of southern Africa (Day 1969) have appeared. Moreover, the recent International Indian Ocean Expedition, resulting in Ledoyer's work (1967a, b) on the Amphipoda of Malagasy has prompted the author's interest in the fauna of the mainland of Moçambique.

Data for this paper were provided by the following:

(a) An extensive survey of Morrumbene estuary by the Zoology Department of the University of Cape Town, involving visits in 1953, 1954, 1955 and 1968. During these expeditions to Moçambique, exploratory collections were also taken at Lagoa Poelela, Maxixe and Jangamo reef and the data from these collections are also included.

(b) Collections from Inhaca Island and Ponta Zavora made by a team of biologists from the South African Museum, Cape Town, in June 1971, and kindly loaned by them to the author.

(c) A series of dredge samples taken by the S.S. *Anton Bruun* during an International Indian Ocean Expedition cruise in 1964.

(d) Information has also been drawn from collections taken at Inhaca Island by the University of the Witwatersrand (Macnae & Kalk 1958, 1962a, b).

THE COLLECTING STATIONS

Fig. 1

Morrumbene estuary

Fig. 2

Description

This rich estuary, fed by the Morrumbene, Inhanombe and other minor rivers, opens into the northern end of Inhambane Bay (at $23^{\circ}40'S/35^{\circ}20'E$). The Inhanombe is the largest of the rivers, flowing northwards through mangrove swamps before reaching a broad mixing basin between the San José Mongué mission station and Morrumbene village. The shallow mixing basin is about 2–3 kilometres wide at flood tide, its banks are mainly muddy in the upper reaches, except for a few sandy areas around Tinga-Tinga; but from the mission station to the mouth the banks are sand and the bottom sandy mud. The tortuous Inhanombe channel is about two metres deep opposite the mission station and reaches a maximum depth of 20 metres at Linga-Linga.

Tidal range at springs is about three metres at Mongué decreasing to two metres at Tinga-Tinga. Salinity (at high and low tides respectively) varied between 35‰ and 31.2‰ at Linga-Linga, 34.4‰ and 22.9‰ at Mongué, and between 33.8‰ and 11.8‰ at Tinga-Tinga.

The banks of the estuary are lined with at least three genera of mangrove

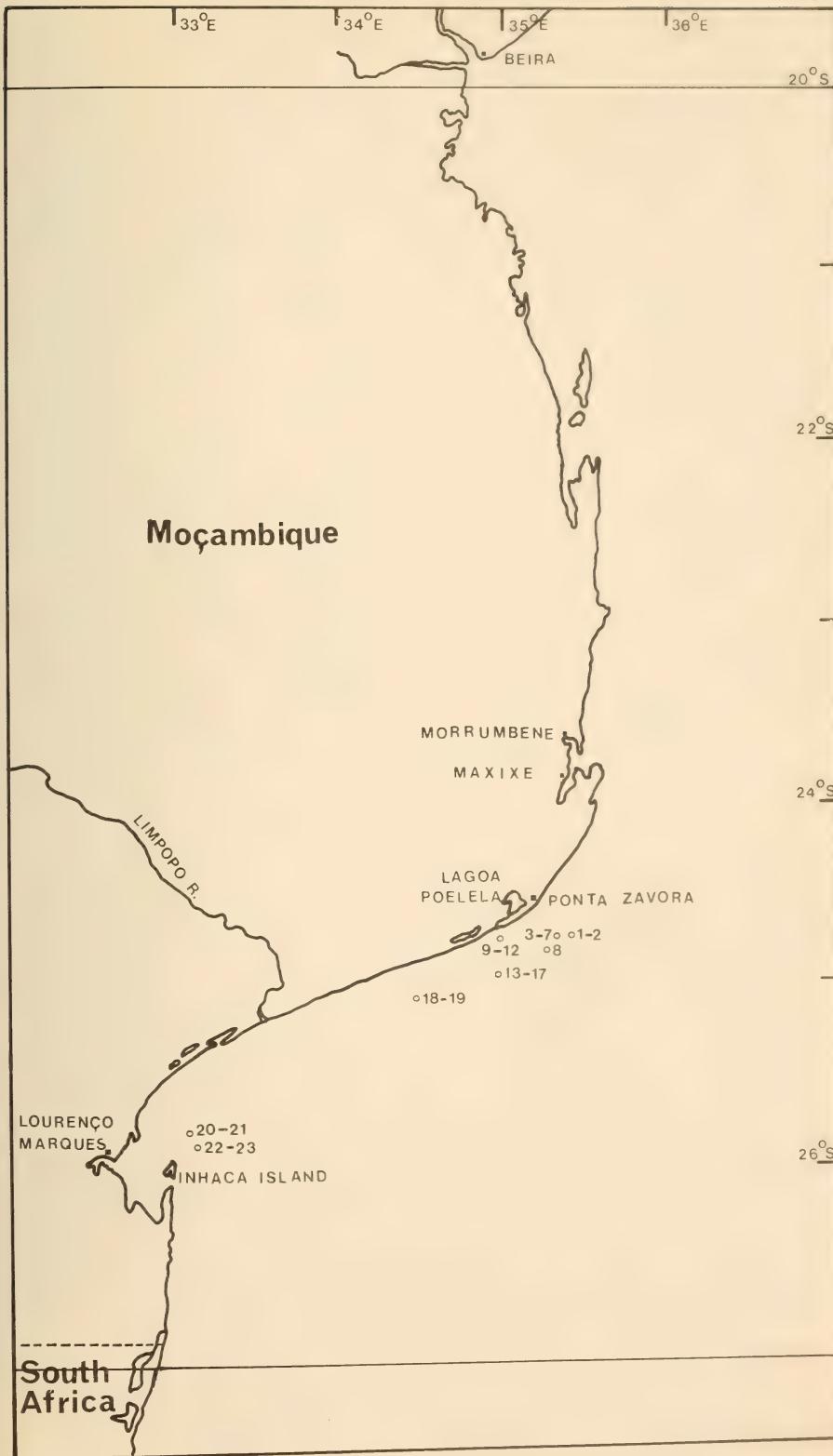


Fig. 1. Collecting stations in southern Moçambique (20° to 27° S) with PED stations numbered.

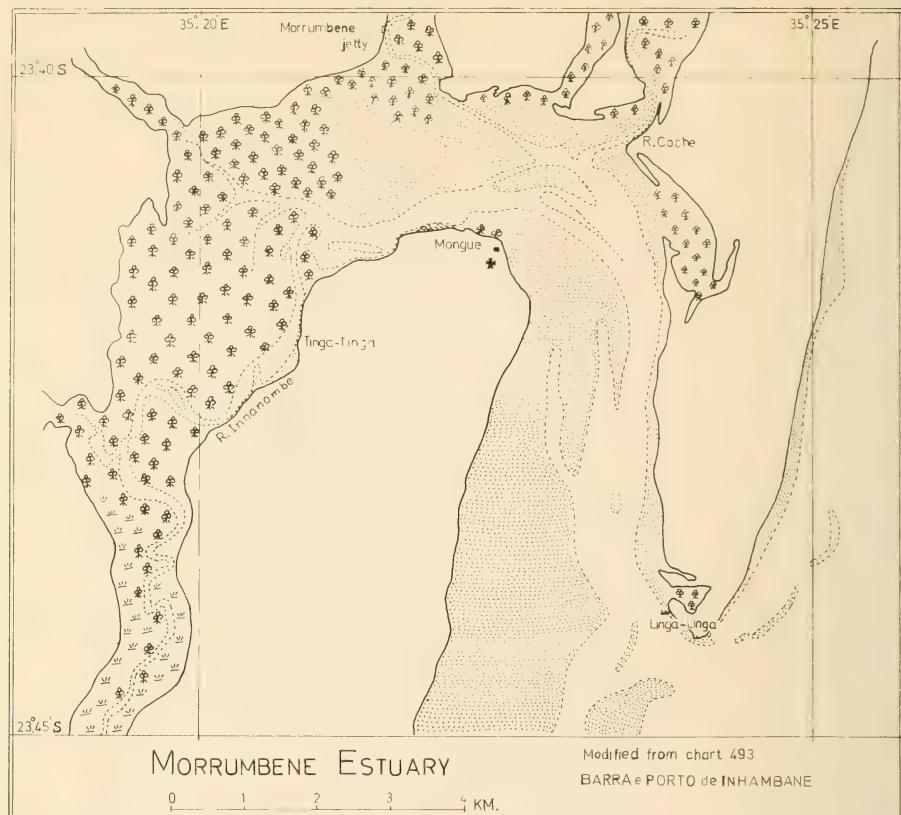


Fig. 2. Morrumbene estuary (after Day, unpublished).

including *Avicennia*, *Rhizophora* and *Ceriops*, these give way to *Phragmites*, *Barringtonia* and *Acrostichum* where salinity falls below 10‰. In the mixing basin sea grasses such as *Halodule* and *Cymodocea* are common near low water springs.

The survey of Morrumbene formed part of the University of Cape Town's estuarine survey series and a paper on the ecology of the estuary is in preparation by J. H. Day. Twenty-two species of amphipod were recovered during the survey. Both the absolute number of individuals and the number of species decreased in areas of low salinity.

Eighteen species were present in the mixing basin, of these only six were at all common (*Cheiriphotis megacheles*, *Grandidierella bonnieri*, *Hyale inyacka*, *Laetmatophilus purus*, *Lembos teleporus* and *Talorchestia australis*). Above Tinga-Tinga seven species were recorded, none of them common.

One particularly euryhaline species worthy of mention is *Grandidierella bonnieri* which was found from Linga-Linga to Tinga-Tinga and also recovered from a fresh-water lake adjoining Lagoa Poelela.

Station list

Catalogue number	Date	Position	Substrate
MOR 30	19/1/54	Midchannel, Tinga-Tinga LWS	Sandy mud
MOR 31	19/1/54	In dense mangroves, Tinga-Tinga	Mud
MOR 37	20/1/54	Mid-tidal level, Linga-Linga	<i>Halodule</i> marsh
MOR 40	20/1/54	Midtide rocks, Linga-Linga	Rock
MOR 41	20/1/54	LWS, Linga-Linga	<i>Halodule</i> marsh
MOR 45	20/1/54	Dredge 6-9 m, Linga-Linga	—
MOR 52	21/1/54	Netting in mouth of Rio Coche	—
MOR 74	24/1/54	Netting at Mongué ferry	<i>Halodule</i> beds
MOR 75	18/1/54	Midtide at Mongué ferry	Sand
MOR 77	23/7/53	Diving 2-3 m, Linga-Linga	Sand and weed
MOR 85	11/7/54	Above HWS at fern bank	Mangrove roots
MOR 95	3/7/54	Handnetting (location?)	Aquatic vegetation
MOR 102	14/7/54	Netting at Linga-Linga	<i>Halodule</i> and <i>Cymodocea</i>
MOR 108	14/7/54	Dredge 1.5-4 m, Linga-Linga	Sand with <i>Cymodocea</i>
MOR 122	15/7/54	Dredge off Linga-Linga	—
MOR 124	15/7/54	Plankton netting, Linga-Linga	—
MOR 147	16/7/54	Netting, mouth of Rio Coche	—
MOR 179	18/7/54	Mangroves at Mongué ferry	—
MOR 180	18/7/54	Mongué ferry, HWS	Sand
MOR 193	19/7/54	Linga-Linga	Sand
MOR 212	15/7/54	LWS, Mongué ferry	Mangroves?
MOR 218	13/7/54	From wreck, Linga-Linga	Ship's hull
MOR 232	12/7/54	Rio Coche	—
MOR 238	12/7/54	Opposite Rio Coche	Sand
MOR 240	12/7/54	Opposite Mongué ferry	Mud
MOR 243	12/7/54	Mongué ferry	—
MOR 244	12/7/54	Mongué ferry	—
MOR 250	12/7/54	Tinga-Tinga	Mangroves
MOR 253	12/7/54	Fern bank	<i>Acrostichum</i>
MOR 255	12/7/54	Head of estuary of Inhanombe River	—

Subsidiary collections made during the expeditions to Morumbene

(a) *Jangamo Reef* lies 96 kilometres south of Inhambane Bay at 24°06'S/35°30'E. A party of biologists from the University of Cape Town, led by Professor J. H. Day, visited the area from 7 to 10 July 1968. The reef was found to be of flat sandstone transected by gulleys and covered by shallow pools, the rock extending from high water neaps to low water springs. *Ulva* was dominant at higher levels, below which there was an area of red algal turf running to low water springs. At low tide *Idanthyrsus* formed large encrustations and zoanthids, algae, sponges, ascidians and hydrozoans fringed the gulleys. Corals were present but not abundant.

The dominant intertidal amphipods were *Elasmopus affinis* and *Elasmopus japonicus* which were present in approximately equal numbers and together accounted for over 75% of the collection. Of the 14 other species recorded, *Caprella equilibra* and *Cheiriphotis megacheles* were the most common.

Station list

Catalogue number	Date	Position
JAN 12, JAN 14	8/7/68	General collection of amphipods

(b) *Lagoa Poela* ($24^{\circ}33'S/35^{\circ}05'E$), one of a series of brack-water lagoons forming a chain along the coast, was briefly visited by a team of University of Cape Town zoologists in January 1954. The lagoon was 30 kilometres long and 5 kilometres wide, the shore clean sand and the water crystal clear without any signs of aquatic vegetation and little sign of aquatic life. At the time of sampling salinity near the shore was 6,5‰ and the temperature at the surface was $19,5^{\circ}\text{C}$.

Only three amphipods were found in the lagoon, *Orchestia ancheidos* was common in weed along the drift-line, *Grandidierella bonnieri* in sand along and above the watermark and *Melita zeylanica* in the weedy shallows. With the exception of *O. ancheidos*, the same species were recovered from an adjoining freshwater lake.

Station list

<i>Catalogue number</i>	<i>Date</i>	<i>Position</i>
POE 1	26/1/54	Netting along the shore
POE 3	26/1/54	Digging between <i>Juncus</i> plants 30 cm above water level
POE 6	26/1/54	Digging in waterlogged sand on shore
POE 8	26/1/54	In weed along driftline
POE 10	26/1/54	Handnetting in weed on the margin of a shallow freshwater lake south-west of the lagoon
POE 12	26/1/54	Collecting along margin of freshwater lake

(c) *Maxixe*. The township of Maxixe, which lies 19 kilometres south of Morrumbene estuary on the western shore of Inhambane Bay, was visited briefly in July 1953.

A rapid examination of the shore revealed only two species of amphipod, *Lembos podoceroides* and *Chevalia aviculae*, both at low tidal levels on the sand banks and piles of the wharf.

Station list

<i>Catalogue number</i>	<i>Date</i>	<i>Position</i>
PEA 2	24/7/53	General collection from low tide sand banks and piles, Maxixe
PEA 4	24/7/53	General collection from low tide sand banks and piles, Maxixe

Inhaca Island

Fig. 3

Detailed ecological descriptions of Inhaca Island may be found in Kalk (1958), Macnae & Kalk (1958) and Kalk & Macnae (1962a, b). The island lies at the tip of the Inhaca peninsula, forming an eastern boundary to Delagoa Bay. It is centred at $26^{\circ}01'S/32^{\circ}56'E$ with a maximum length of 11 kilometres and a width of 6 kilometres. The mangrove fringed northern bay and the Saco da Inhaca in the south contain extensive mud flats dominated by *Halodule* and *Cymodocea* through which narrow channels run. The Saco is more rocky than the northern bay and there is a young coral reef near Ponto Torres.

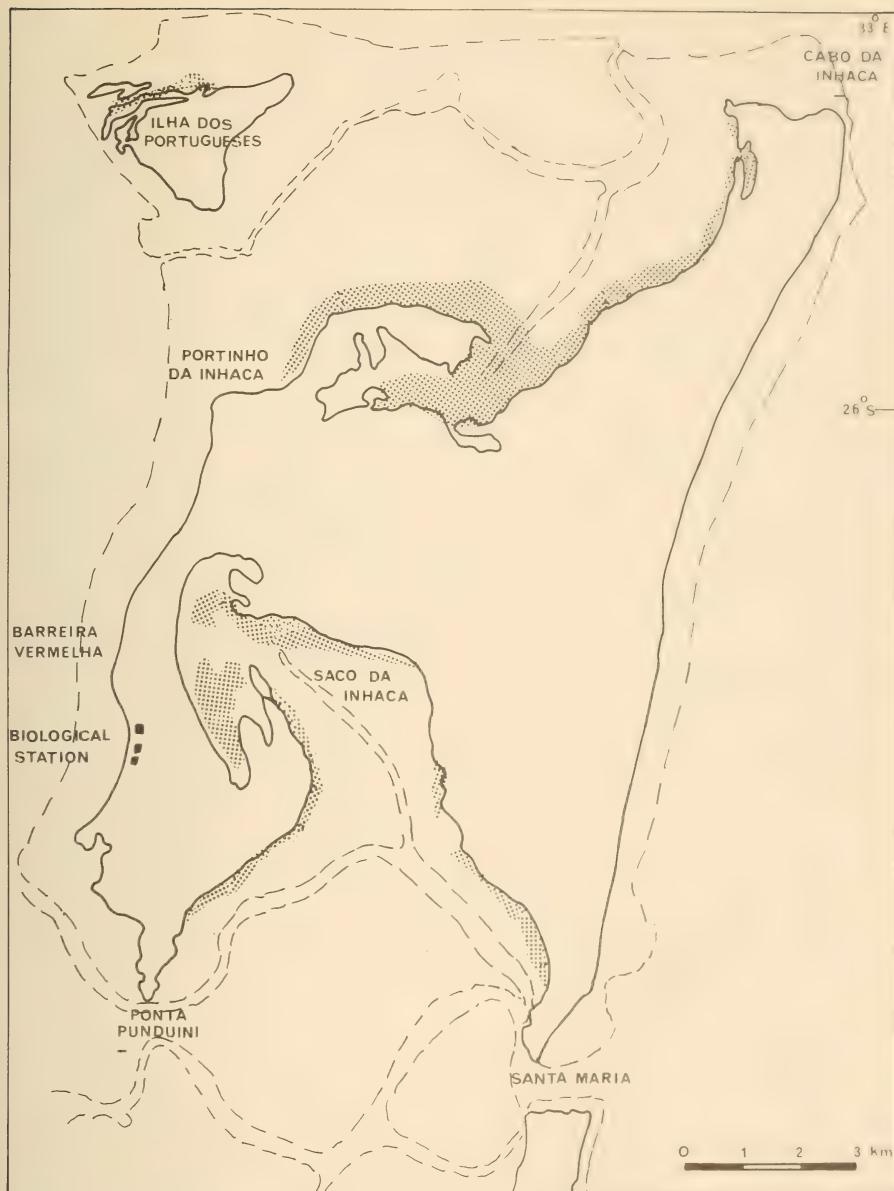


Fig. 3. Inhaca Island, showing features referred to in the text (after Macnae & Kalk, 1958).

The west coast, which borders shallow Delagoa Bay, exhibits intertidal sand flats up to 1 kilometre wide. These are often covered by coral debris or *Cymodocea* and opposite Barreira Vermelha there is a coral reef.

The eastern shore is exposed to the surf and is rocky along its whole length, though the rocks are usually only at intertidal levels. At Cabo da Inhaca there are three rock terraces, the highest not now immersed at any state of tide.

The island provides an extremely wide range of habitats, rock and sand being present in both exposed and sheltered areas at all tidal levels. Moreover, the landward side of the island, bathed by the warm waters of shallow Delagoa Bay, apparently represents an isolated area of true tropical fauna, while the open coast is considered subtropical, with coral growing on the rocks, rather than forming true reefs.

A collection of amphipods was made on the island by a team from the South African Museum in June 1971 and these, together with the species recorded by Macnae & Kalk, reveal a total of 22 species. Of the 16 species recovered during the South African Museum's brief collecting visit, 11 were new to Inhaca, an indication of the number of species still to be discovered.

The fauna is best grouped according to area of occurrence. In the northern bay, only one species is found, *Orchestia anomala*, which is common along the drift line. The eastern seaboard is also sparsely populated, only *Hyale grandicornis*, *Stenothoe valida* and a species of *Podocerus* having been found.

The southern bay is the richest area with 16 recorded species. Important among these are *Maera hamigera* and *Maera inaequipes*, which are common in coral. *Cymadusa filosa*, *Ampithoe ramondi*, *Elasmopus affinis* and *Talorchestia australis* are common intertidally.

On the more muddy, sheltered west coast, 13 species have been found. *Cymodocea* is a habitat favoured by *Ericthonius brasiliensis*, *Cymodusa filosa*, *Caprella scaura* and *Aora typica*, while *Orthoprotella mayeri* is common on the hydroid *Lytocarpus*. *Maera hamigera* and *Maera inaequipes* once again occur in coral. At high intertidal levels *Orchestia anomala* occurs among *Bostrychia*, *Hyale inyacka* under rocks on sand and *Talorchestia australis* under weed on the drift line.

Station list

<i>Catalogue number</i>	<i>Date</i>	<i>Position</i>
IN 158	June 1971	In a sponge, Saco da Inhaca
IN 159	June 1971	General collection, Santa Maria
IN 160	June 1971	General collection on mud, west coast
IN 161	June 1971	On <i>Cymodocea</i> , west coast

During their visit to Inhaca, biologists from the South African Museum also briefly visited Ponta Zavora ($30^{\circ}02'S/35^{\circ}10'E$) where they found five species of amphipod in the intertidal zone. *Elasmopus japonicus* and *Cymodusa*

filosa were fairly common, while single specimens of *Gammaropsis semichelatus*, *Amaryllis macrophthalma* and *Maera* sp. (female) were collected.

Dredge stations

Samples from 23 dredges forming part of a series taken by the S.S. *Anton Bruun* in August 1964 were donated to the University of Cape Town and are incorporated in the survey.

Station list

Cat. no.	Date	Position	Depth (m)	Substrate	Gear
PED 1-2	18/8/64	24°46'S/35°20'E	132	Rock and shelly sand	Rock dredge
PED 3-7	18/8/64	24°46'S/35°18'E	110	Coarse sand and rock	Rock dredge
PED 8	18/8/64	24°49'S/35°13'E	73	Shelly sand and rock	Rock dredge
PED 9-12	19/8/64	24°46'S/34°50'E	22	Shelly sand and rock	Rock dredge
PED 13-17	19/8/64	24°53'S/34°56'E	55	Fine grey sand and rock	Rock dredge
PED 18-19	19/8/64	25°07'S/34°34'E	112	Dark sandy mud	Agassiz dredge
PED 20-21	22/8/64	25°57'S/33°02'E	42	Shell and rock	Rock dredge
PED 22-23	22/8/64	26°00'S/33°05'E	135	Shell and rock	Rock dredge

These samples contained 27 species of amphipod, apparently separable into two groups according to substrate preferences.

Areas with fine substrates (PED 13-18) revealed 16 species while the coarser bottomed areas revealed 11 species, only five being common to both substrate types.

On shell, sand and rock, the most important species were *Gammaropsis atlantica*, *Maera inaequipes*, *Maera serrata* and *Orthoprotella mayeri*.

In the fine sand and mud areas no one species was recovered in even moderate numbers, indicating a sparse, mixed population of mud-loving burrowing types (such as *Ampelisca*, *Podocerus*, *Metaphoxus* and *Urothoe*). The few caprellids found here would have been living on the occasional rocks present.

SYSTEMATICS

The form of presentation used here follows that of J. L. Barnard and J. C. McCain, in that families, and genera within families, are presented in alphabetical order.

It will be noted that many major taxonomic changes have taken place in the years since K. H. Barnard's (1940) key to South African Amphipoda. The reader is referred to J. L. Barnard (1969b, 1970a) for diagnosis of gammaridian taxa and to J. L. Barnard (1958) for a world species list. Information on the revised taxonomy of Caprellidea may be found in McCain (1970) and McCain & Steinberg (1970), the latter work also including bibliographies and synonomies for all known species.

For the convenience of readers unfamiliar with recent developments, relevant changes at family level since 1940 are listed below:

Old taxa

New taxa

Atylidae	Incorporated into Dexaminidae
Lepechinellidae	
Hyalellidae	Incorporated into Superfamily
Hyalidae	Talitroidea
Talidae	
Photidae	Incorporated into Isaeidae
Metopidae	Incorporated into Stenothoidae
Pontigeneiidae	Incorporated into Eusiridae
Jassidae	Becomes Ischyroceridae
Caprellidae	Split to form Phtisicidae Caprellidae (revised) Aeginellidae Caprogammaridae

In the following account, no attempt has been made to provide a full list of references or synonyms, but the reader is referred to works which will provide good descriptions and synonymy lists, and to those which refer specifically to the southern African region.

The holotypes of all new species have been placed in the South African Museum, Cape Town, the S.A.M. Catalogue numbers given are museum numbers, while other codes (MOR, PED, etc) refer to University of Cape Town collections, the number in brackets after the code refers to the number of individuals found.

Suborder GAMMARIDEA

Family **Ampeliscidae**

Ampelisca diadema (Costa, 1853)

Ampelisca assimilis: Sars, 1895: 168, pl. 58.

Ampelisca diadema: K. H. Barnard, 1916: 133.

Records: PED 15J (2).

Diagnosis: Article 3 of pereiopod 5 longer than article 4; pereon segments 5-7 with ventral hooks; third pleonal epimeron rounded; pleon segment 4 with a high, evenly-rounded dorsal carina; antenna 1 slightly exceeding peduncle of antenna 2.

Distribution: Cosmopolitan.

Ampelisca fusca Stebbing, 1888

Ampelisca fusca Stebbing, 1888: 1052, pl. 105.

Records: PED 6K (1); PED 23Q (6).

Diagnosis: Article 4 of pereiopod 5 twice the length of article 3, produced posteriorly to cover half article 5, produced portion setose, article 5 slightly produced anteriorly; four eyes, with corneal lenses, lower pair directed forward; pleon segment 4 saddle-shaped dorsally; antennae 1 and 2 equal and as long as body.

Distribution: Endemic, Cape Agulhas to Moçambique.

Ampelisca palmata Barnard, 1916

Ampelisca palmata K. H. Barnard, 1916: 136, pl. 28, figs 30–31.

Records: PED 15H (2).

Diagnosis: Article 3 of pereiopod 5 longer than article 4, 4 with front apex narrowly produced along half the length of 5; third pleonal epimeron quadrate, scarcely produced; pleon segment 3 with a low subacute dorsal keel; antenna 1 ♀ much longer than peduncle of antenna 2.

Distribution: Southern and west Africa.

Family **Amphilochidae***Gitanopsis mariae* n. sp.

Fig. 4

Diagnosis of male: Head with extremely large probosciform rostrum, lateral cephalic lobe quadrate, eye of moderate size, black. Antenna 1 not setose, as long as head, flagellum seven-articulate, accessory flagellum absent. Antenna 2 slightly longer than 1, flagellum seven-articulate. Mandible with large triturative molar, palp article 1 distally expanded, articles 2 and 3 subequal, article 3 distally curved. Maxilla 1, palp biarticulate. Outer plate of maxilla 2 narrower than inner. Outer lobe of maxilliped slightly excavate, palp four-articulate, articles 1 and 2 subequal and article 2 expanded distally.

Gnathopods 1 and 2 very weak and slender with gnathopod 2 slightly the larger. Coxa 1 rounded and very small, partially concealed by coxa 2. Coxa 3 antero-distally produced, coxa 4 deeply excavate posteriorly.

Pereiopods 3–5, article 2 almost as wide as long. Third pleonal epimeron rounded and somewhat produced postero-inferiorly.

Uropods 1–3, outer rami marginally shorter than inner. Telson dorsally excavate, 70% length of peduncle of uropod 3, tapering distally, apically tridentate.

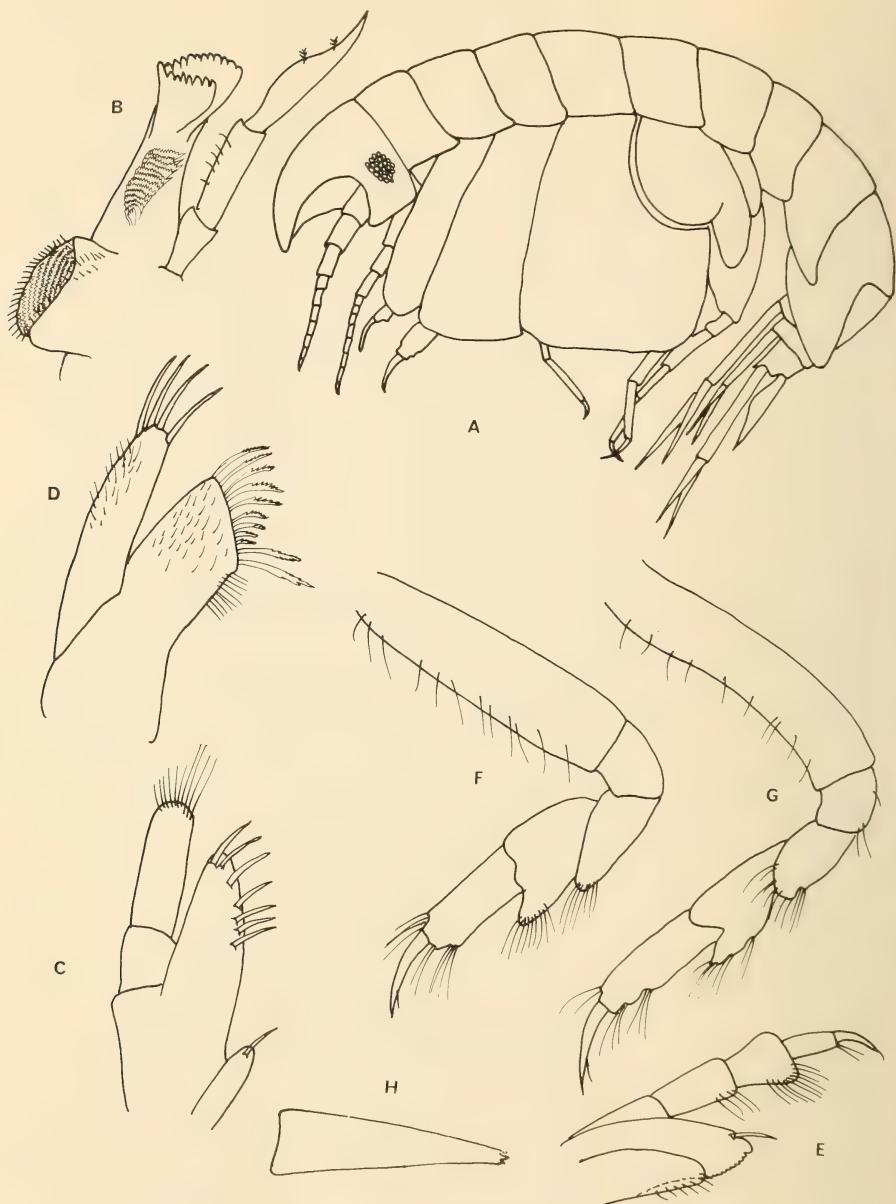


Fig. 4. *Gitanopsis mariae* n. sp., holotype, male, 7 mm.

A. Lateral view. B. Mandible. C. Maxilla 1. D. Maxilla 2. E. Maxilliped. F. Gnathopod 1.
G. Gnathopod 2. H. Telson.

Holotype: Male, 7 mm, unique. S.A.M. A 13066.

Type-locality: Collected at Santa Maria, Inhaca Island, by biologists of the South African Museum, June 1971.

Records: IN 159J.

Remarks: This species is easily recognized by its distinctive rostrum, which is much larger than is usual in this genus, and by the extremely weak gnathopods, which are unlike those of any other representatives of the genus.

Gitanopsis pusilla Barnard, 1916

Gitanopsis pusilla K. H. Barnard, 1916: 144. Stephensen, 1949: 8, fig. 1.

Records: PED 21E (1); IN 158C (1).

Diagnosis: Distinguished from other members of the family by the very short pyriform telson which is less than half the length of the peduncle of uropod 3; body smooth; process of article 5 of gnathopod 1 extending half the length of article 6, palm transverse, convex, defined by two spines.

Distribution: Tristan da Cunha, Kerguelen, South Georgia, Lambert's Bay to Moçambique.

Family **Ampithoidae**

Ampithoe ramondi (Audouin, 1826)

Ampithoe vaillanti: K. H. Barnard, 1916: 253.

Ampithoe ramondi: J. L. Barnard, 1970b: 50, figs 18–19.

Records: IN 159C (8); JAN 12J (1); MOR 74J (1); MOR 212C (2).

Diagnosis: Accessory flagellum absent; gnathopods 1 and 2 with article 2 lobed; palm of gnathopod 2 defined by a conspicuous lobelike tooth, dactyl serrate; outer ramus of uropod 3 terminating in two strongly recurved spines.

Distribution: Cosmopolitan in warm and temperate seas.

Cymadusa filosa Savigny, 1818

New synonymy:

Grubia australis K. H. Barnard, 1916: 258.

Grubia filosa: Shoemaker, 1935: 245, figs 4, 5.

Cymadusa australis: K. H. Barnard, 1940: 480.

Cymadusa filosa: J. L. Barnard, 1955: 29, fig. 15.

Records: MOR 218D (1); IN 160B (3); JAN 12C (2); PEA 24C (3).

Remarks: *C. australis* has previously been separated from *C. filosa* by the lack of plumose setae on antenna 2 and coxae 1–4 in the adult male, and by the lack of

distal lobes on article 2 of gnathopods 1 and 2. Barnard's types of *C. australis*, however, included only one adult male, and subsequent samples (including some from the type locality) identified by Barnard as *C. australis* did have plumose setae. Re-examination of the type specimens has shown that small pellucid lobes on the gnathopods are present, and that the females do not differ in any respect from females of *C. filosa*.

Since no more material corresponding to the male type of *C. australis* has been found, it seems more than likely that the one male type is aberrant, having failed to develop the plumose setae of an adult male. (It is well known that plumose setae develop with maturity and are fully developed only in aged males.)

The largest specimen so far recovered, a male of over 30 mm, showed plumose setae on the telson, fringing the peduncles of the uropods, on the anterior edge of article 2 of the pereiopods and the gnathopods, on the peduncle of antenna 2 and on the ventral margin of the head.

Distribution: Circumtropical.

Paragrubia vorax Chevreux, 1901

Fig. 5

Paragrubia vorax: J. L. Barnard, 1965: 541, fig. 35. Ledoyer, 1967: 135, fig. 23.

Records: JAN 12B (3) (the first record of this species from the southern African mainland).

Diagnosis: Gnathopod 1 considerably larger than 2, article 6 broadly expanded in adult males, palm slightly oblique and strongly concave. Young males show a strong palmar spine but this is lost with age. Accessory flagellum present.

Distribution: Tropical Indo-Pacific.

Family **Aoridae**

Aora typica Kröyer, 1845

Aora typica: Ledoyer, 1967: 131, fig. 15.

Records: IN 161 A (1).

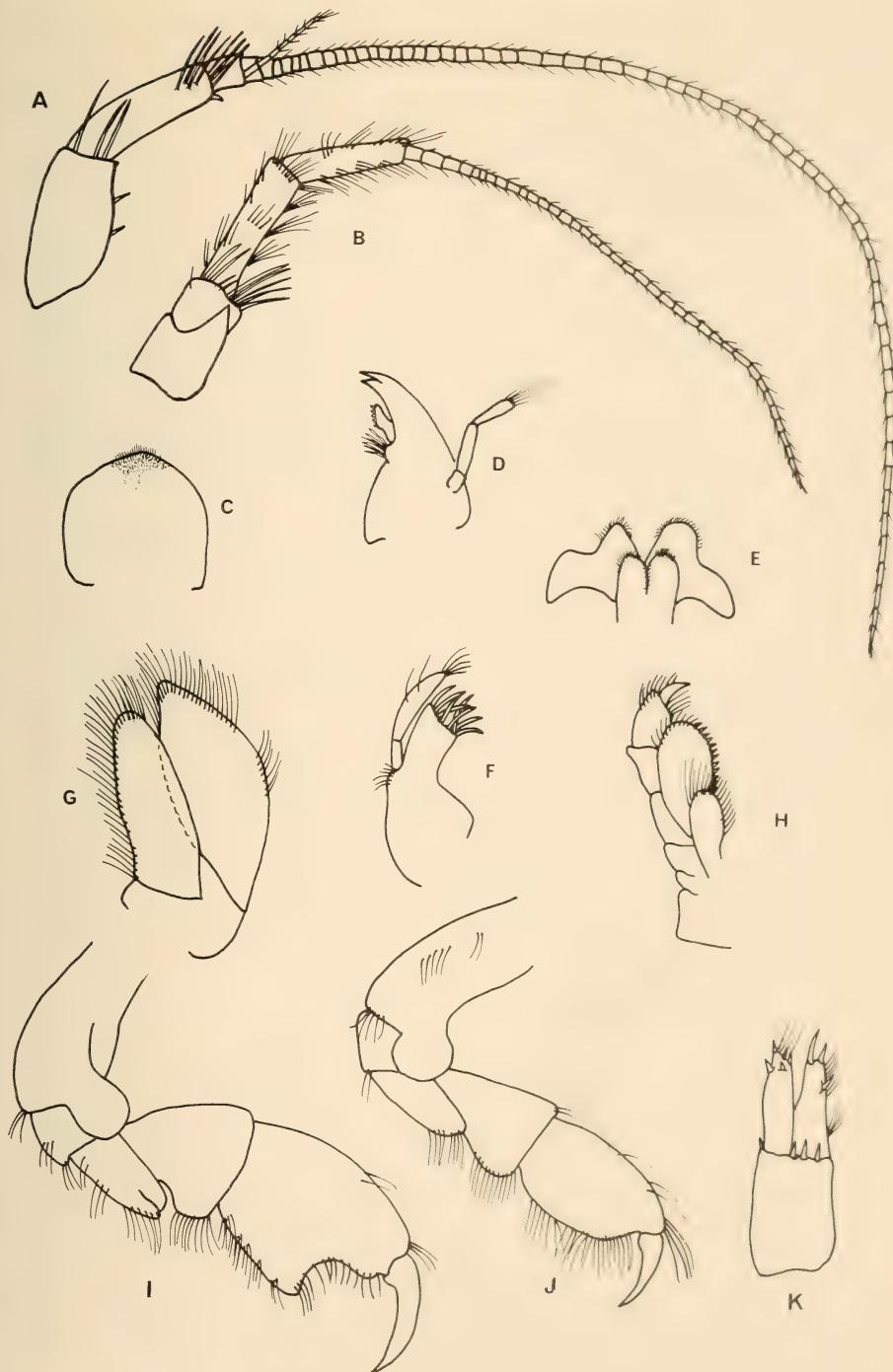
Diagnosis: Easily recognized by gnathopod 1 which has a proximal tooth on the anterior margin of article 2 and a long distal projection on article 4.

Distribution: Cosmopolitan.

Lembos podoceroides Walker, 1904

Lembos podoceroides Walker, 1904: 279, pl. 6.

Records: PED 6 Q (2); PEA 2 L (6).

Fig. 5. *Paragribus vorax* Chevreux, male, 10 mm.

A. Antenna 1. B. Antenna 2. C. Upper lip. D. Mandible. E. Lower lip. F. Maxilla 1. G. Maxilla 2.
H. Maxilliped. I. Gnathopod 1. J. Gnathopod 2. K. Uropod 3.

Diagnosis: Gnathopod 2 of male with the base of the hand produced backwards in a long pointed spur and the palm with a small semicircular sinus near the finger hinge; the posterior and lower margins of the third pleonal epimeron are convex and the postero-inferior corner is slightly produced with a diagonal ridge running across the epimeron to it.

Distribution: Indian Ocean, Red Sea.

Lembos teleporus Barnard, 1955

Lembos teleporus K. H. Barnard, 1955: 94, fig. 47. Ledoyer, 1967: 135, figs 16–17.

Records: IN 160 C (2); MOR 77 W (7); MOR 102 P (2); MOR 147 J (1); MOR 212 H (21).

Diagnosis: Pereon segment 3 with a strong ventral spine in adult males; article 6 of gnathopod 1 male three times the length of article 5, widening distally, palm with a blunt tooth near finger hinge, palmar angle quadrate, palm and dactyl crenulate.

Distribution: Malagasy, Moçambique, South West Africa.

JANICE, n. gen.

Generic diagnosis (male): Article 3 of antenna 1 shorter than article 1, accessory flagellum absent; gnathopod 1 subchelate, articles 4–6 lacking teeth, article 6 slightly shorter than, and of subequal width to, article 5; gnathopod 2 heavily setose, article 4 projecting to protect article 5 posteriorly, article 5 wider than 6 but subequal in length; uropod 3 uniramous, ramus equal to peduncle.

Remarks: The lack of teeth on gnathopod 1 and the complete lack of accessory flagellum are alone sufficient to demand the erection of a new genus. In addition, the structure of gnathopod 2 is unique among Aoridae.

Type-species: *Janice spinidactyla* n. sp.

Janice spinidactyla n. sp.

Fig. 6

Diagnosis of male: Head as long as two pereon segments; eyes small, round, dark. Antenna 1 extending to end of pereon segment 5, ratio of peduncular articles 2 : 3 : 1, flagellum subequal to peduncle and composed of 18 articles, accessory flagellum absent. (Antenna 2 missing.) Mandible with large triturative molar and three-articulate palp, lacinia mobilis 2-toothed with seven spines proximally.

Gnathopod 1 larger than 2, subchelate, articles 4–6 lacking teeth, setose posteriorly, article 6 as wide as, but slightly shorter than, article 5, palm transverse, convex, defined by two large spines and with a few small spines along its edge, dactylus slightly longer than palm and cut into four teeth.

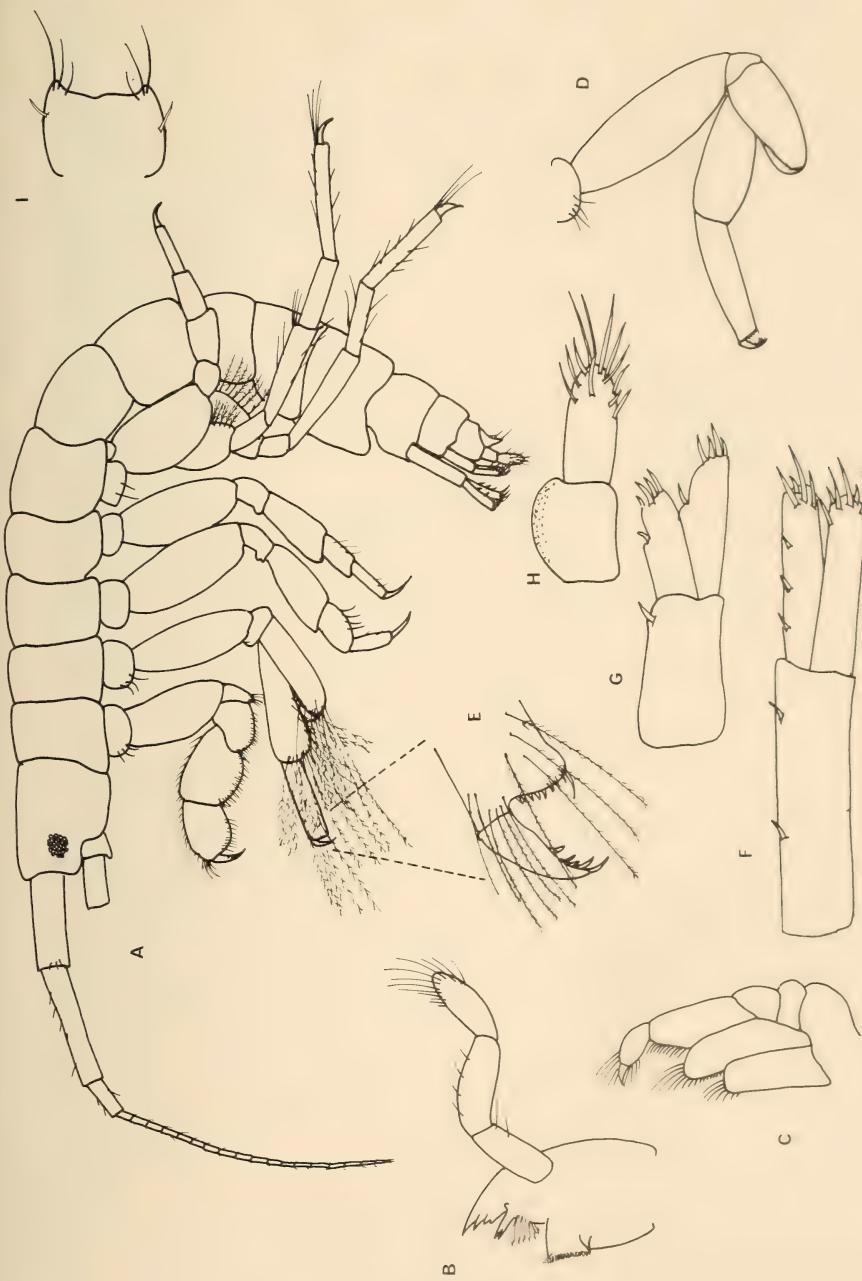


Fig. 6. *Janice spinidactyla* n. gen., n. sp., holotype, male 6 mm.
 A. Lateral view. B. Mandible. C. Maxilliped. D. Gnathopod 2 without its setae. E. Tip of article 6 and article 7 of gnathopod 2. F. Uropod 1. G. Uropod 2. H. Uropod 3. I. Telson.

Article 4 of gnathopod 2 with a spoon-shaped projection extending nearly half the length of article 5, with long, plumose setae along its margins; article 5 as long as, and wider than, article 6 and extremely setose posteriorly, article 6 narrow, palm transverse; four large and many small spines along its length; dactylus matching palm with ten spines which become longer distally.

Pereiopods 1 and 2 glandular; pereiopods 3-5 with article 2 slightly expanded, that of pereiopod 5 extremely setose posteriorly.

Uropod 1 projecting to the end of uropod 3, rami subequal and $\frac{3}{4}$ length of peduncle, each bearing three spines dorsally and five or six terminally. Uropod 2 half the length of 1, rami subequal and slightly shorter than peduncle, each with one dorsal and five terminal spines. Uropod 3 half the length of 2, uniramous, ramus slightly longer than peduncle, cylindrical, terminating in about 12 long spines.

Telson not extending to end of peduncle of uropod 3, emarginate, fleshy, two lateral and three terminal setae on each side.

Holotype: Male, 6 mm. S.A.M. A 13067.

Type-locality: Found amongst *Acrostichum*, Morrumbene estuary above Tinga-Tinga, 12 July 1968. Salinity at capture site 10‰.

Records: MOR 253L.

Paratype: One male, MOR 253L.

Family **Colomastigidae**

Colomastix pusilla Grube, 1864

Colomastix pusilla: H. K. Barnard, 1925: 346. J. L. Barnard, 1955: 39-42, fig. 20.

Records: MOR 283 L (1).

Diagnosis: Distinguished from other members of the family by the smoothly rounded telson; uropod 3 rami equal; eyes in live specimen with red lenses outlined in white; flagellum of antenna 1 two-articulate.

Remarks: Probably considerably more common than the literature suggests since, with its small size and slender body, it is likely to pass through the sorting screens used by many workers.

Distribution: Cosmopolitan in tropical and temperate seas.

Family **Corophiidae**

Cerapus tubularis Say, 1818

Cerapus abditus: Stebbing, 1910b: 616, pl. 55A.

Cerapus tubularis: J. L. Barnard, 1962: 61, figs 27-28. Ledoyer, 1967: 137, fig. 27.

Records: MOR 108 F (1); PED 7 Q (2); PED 11 X (4); PED 12 W (4).

Diagnosis: Rostrum prominent; article 3 of antenna 1 as long as article 1, article 1 with a sharp ventral projection; gnathopod 2 male extremely powerful, article 5 with a large postero-distal triangular process and a smaller process near the articulation with article 6; uropod 2 uniramous.

Remarks: *C. abditus* has been found to be the adult of *C. tubularis*, the main source of misidentification having been Stebbing (1906) who restricted *C. tubularis* to forms with only three flagellar articles on antenna 1, whereas the number is, in fact, variable between two and five. Possibly development in colder regions is retarded, making the terminal 'abditus' type rarer.

Distribution: Cosmopolitan in warm and temperate seas.

Corophium triaenonyx Stebbing, 1904

Corophium triaenonyx Stebbing, 1904: 25, pl. 6A. K. H. Barnard, 1940, 482.

Records: MOR 238 K (1); MOR 240 G (1); MOR 243 X (1); MOR 253 D (1); IN 158 A (2).

Diagnosis: Antenna 2 male with article 4 distally produced into a large curved tooth, a smaller tooth on its inner side; article 7 of gnathopod 2 markedly tri-dentate, the third and largest tooth forming the unguis, pleon segments 4-6 distinct.

Distribution: Tropical Atlantic, Indian Ocean, Mediterranean, Chilka Lake.

Ericthonius brasiliensis (Dana, 1853)

Ericthonius brasiliensis: Stebbing, 1910a: 463. J. L. Barnard, 1955: 37. Ledoyer, 1967: 137, fig. 30.

Records: MOR 218 E (1); JAN 12 H (8); PED 10 T (1); PED 15 M (1); amongst *Cymodocea* at Inhaca (Macnae & Kalk, 1958).

Diagnosis: Head not rostrate; gnathopod 2 male very powerful, article 5 postero-distally with a large bidentate process, dactyl very strong, falciform; uropods 1 and 2 sublamellar, minutely pectinate, uropod 3 uniramous, ramus half the length of peduncle and bidentate at tip.

Distribution: Cosmopolitan in tropical and temperate seas.

Grandidierella bonnieri Stebbing, 1908

Grandidierella bonnieri: Ledoyer, 1967: 137, fig. 28a.

Records: MOR 30 T (3); MOR 30 U (3); MOR 41 N (1); MOR 52 N (2); MOR 74 H (7); MOR 77 Z (3); MOR 102 N (1); MOR 240 F (7); MOR 243 Y (1); POE 1 A (1); POE 3 D (common); POE 6 A (common); POE 10 F (1); POE 12 G (5).

Diagnosis: Pereon segment 1 in male with a strong medio-ventral spiniform

process; gnathopod 1 male with article 5 not narrowing distally, a strong spinose projection on inner apical corner, a smaller one on the distal margin, and a spine on the lower margin.

Distribution: Atlantic and Indian Oceans, Caribbean.

Siphonoecetes orientalis Walker, 1904

Siphonoecetes orientalis Walker, 1904: 294, pl. 7, fig. 49. K. H. Barnard, 1916: 270.

Records: MOR 124 F (2).

Diagnosis: Eyes poorly developed; flagellum of antenna 2 of one long and two short densely setose articles with characteristic marginal and apical unguiform spines; flagellum of antenna 1 subequal to peduncle and consisting of 10–14 articles; rostrum acute and deflexed.

Distribution: Tropical Indo-Pacific.

Family **Dexaminiidae**

Polycheria atolli Walker, 1905

Polycheria antarctica: K. H. Barnard, 1916: 211.

Polycheria atolli: Ledoyer, 1967: 131, fig. 13a.

Records: PED 10 P (4); PED 15 Q (1).

Diagnosis: Urosome segments with dorsal carinae, segments 2 and 3 fused; pereiopods chelate; uropods 1 and 3 subequal, 2 much shorter with outer ramus half the inner; telson cleft to base.

Distribution: Antarctic and southern Oceans, tropical Indian Ocean.

Family **Eusiridae**

Eusiroides monoculoides (Haswell, 1880)

Eusiroides monoculoides: K. H. Barnard, 1916: 174. J. L. Barnard, 1964: 221, fig. 1.

Records: PED 15 K (1).

Diagnosis: Gnathopods subchelate, article 5 lobate, shorter than 6; third pleonal epimeron posteriorly convex with 10–12 upturned teeth; telson cleft half its length, apices bidentate.

Distribution: Circumtropical.

Family **Gammaridae**

Elasmopus affinis Della Valle, 1893

Elasmopus affinis: Sars, 1895: 521, pl. 183.

Records: JAN 12 K (1); JAN 12 M (105); IN 159 G (f.c.); PED 10 R (4); PED 15 N (2).

Diagnosis: Pereiopods robust, article 2 of pereiopod 5 two-thirds as wide as long; outer ramus of uropod 3 larger than inner, two fascicles of spines on outer edge, tips of both rami obliquely truncate and densely spinose; telson narrowly cleft, tip of each lobe obliquely truncate with three or four apical spines. Gnathopod 2 ♂ with 3-spined tubercle at base of dactylus.

Distribution: Mediterranean, Atlantic, southern Indian Ocean.

Elasmopus japonicus Stephensen, 1932

Elasmopus spinimanus (non Walker, 1905): K. H. Barnard, 1925: 358.

Elasmopus japonicus: Sivaprakasam, 1968: 278, figs 3-5.

Records: JAN 12 A (98); PEA 24 E (8).

Diagnosis: Article 6 of gnathopod 2 large, a rounded process at the base of the dactylus bears eight strong spines on its margin and three more at its base, finger less than half the length of article 6.

Remarks: The specimens identified by K. H. Barnard (1916) have a dorsal keel on pleon segment 4 which excludes them from *E. spinimanus*. They agree closely with Stephensen's figures of *E. japonicus*.

Distribution: Indo-Pacific, extending to South West Africa.

Maera hamigera (Haswell, 1880)

Maera hamigera: K. H. Barnard, 1916: 196, pl. 27, figs 11-12. J. L. Barnard, 1965: 507, fig. 16.

Records: IN 158 B (4); IN 159 A (8); IN 160 E (1).

Diagnosis: Body not dorsally dentate, posterior edge of third pleonal epimeron serrate; uropod 3 extending much beyond 1 and 2, rami equal; right gnathopod 2 male larger than the left, palm defined by a strong tooth followed by a marked concavity and a number of further teeth (six in these specimens but variable).

Distribution: Indo-Pacific.

Maera inaequipes (Costa, 1851)

Maera inaequipes: K. H. Barnard, 1916: 193. J. L. Barnard, 1959: 25, pl. 5.

Records: JAN 12 D (1); IN 160 A (1); PED 23 S (1).

Diagnosis: Gnathopod 2 with a sinus in centre of transverse palm, the stout dactylus having a rounded tooth which fits the depression; article 2 of pereiopod 5 with six or seven serrations; uropod 3, rami unequal, truncated; telson cleft to base, each lobe bidentate, with four or five terminal spines.

Distribution: Cosmopolitan in tropical and temperate seas.

Maera serrata Schellenberg, 1938*Maera inaequipes serrata*: Ledoyer, 1967: 127, fig. 9.*Maera serrata*: J. L. Barnard, 1970b: 155, figs 96-97.*Records*: PED 6 S (1); PED 10 N (19).*Diagnosis*: Differs from *M. inaequipes* only by the serrated posterior border of the third pleonal epimeron; the number of serrations is variable, the present specimens having from three to seven teeth.*Distribution*: Indo-Pacific (this is the first record from the southern African mainland).*Mallacoota subcarinata* (Haswell, 1880)*Elasmopus subcarinatus*: Stebbing, 1910: 458.*Maera subcarinata*: K. H. Barnard, 1940: 460, fig. 26.*Records*: PED 21 D (1).*Diagnosis*: Pleon segment 3 bicarinate, the two teeth apically inclined towards one another; gnathopod 2 palm spinose with a central cavity containing a strong tooth; telson with widely divergent lobes, their tips bidentate.*Distribution*: Indian Ocean, Pacific, Mediterranean.*Melita appendiculata* (Say, 1818)*Melita fresneli*: Stebbing, 1910b: 596. K. H. Barnard, 1916: 189, pl. 28, fig. 32.*Melita appendiculata*: J. L. Barnard, 1970b: 161, figs 103, 104.*Records*: MOR 45 E (2); MOR 45 G (2); MOR 77 V (5); MOR 124 D (1); PED 15 F (6); PED 18 U (1); IN 159 D (4).*Diagnosis*: Pleonal tooth formula 7 : 7 : 7 : 5 : 2; pleonal epimeron 3 produced into a long tooth; gnathopod 2 male unequal, either the larger, article 6 with a characteristic spoon-shaped palm, three teeth near finger hinge, dactyl powerful, hind margin of article 6 longer than front margin; article 2 of pereiopods 4 and 5 narrowing distally, not produced postero-inferiorly.*Distribution*: Cosmopolitan.*Melita zeylanica* Stebbing, 1904*Melita inaequistylis*: (part) K. H. Barnard, 1916: 191.*Melita zeylanica*: Sivaprakasam, 1966: 112, fig. 12a-j.*Records*: MOR 95 D (3); MOR 253 C (F.C.); POE 10 G (3); POE 12 F (F.C.).*Diagnosis*: Pleon without dorsal teeth, segment 2 with two or three submedian fascicles of spines on each side; gnathopod 1 with short palm distally produced into a setose lobe into which the dactylus fits.

Remarks: K. H. Barnard (1916) doubtfully synonymized Walker's (1904) *M. tenuicornis* but this has not been accepted since Walker's specimens had pleonal teeth while Barnard's did not.

Distribution: A brackwater species found in India, Ceylon and southern Africa.

Family **Haustoriidae**

Urothoe elegans Bate, 1857

Urothoe elegans: Ledoyer, 1968: 23, pl. 5.

Records: PED 18 X (1).

Diagnosis: Distinguished from other southern African species by articles 4 and 5 of pereiopod 3, which are longer than broad; dactyl of pereiopod 3 minutely denticulate.

Distribution: Atlantic and Indian Oceans.

Family **Isaeidae**

Cheiriphotis megacheles (Giles, 1885)

Cheiriphotis durbanensis K. H. Barnard, 1916: 247.

Cheiriphotis megacheles: J. L. Barnard, 1962: 17, fig. 4.

Records: MOR 37 W (4); MOR 41 M (2); MOR 45 F (4); MOR 77 X (4); MOR 77 Y (7); MOR 238 E (C.); JAN 12 N (29).

Diagnosis: A polymorphic species, young specimens having a moderately well-developed inner ramus to uropod 3 which disappears in fully developed adults; gnathopod 2 male changes from an oblique palmed form bearing three large teeth to a transverse one bearing four or five small irregular teeth; article 3 of antenna 1 shorter than 1 or 2, accessory flagellum tri-articulate.

Distribution: Indo-Pacific.

Chevalia aviculae Walker, 1904

Chevalia aviculae: K. H. Barnard, 1916: 252. J. L. Barnard, 1970b: 166, fig. 107.

Records: PEA 4 L (5).

Diagnosis: Accessory flagellum of antenna 1 uniarticulate; gnathopod 2 stout, article 6 subquadrate, palm transverse, convex, defined by a strong tooth; pereiopods 3 and 5, dactyl bifurcate; urosome segments 1 and 2 coalesced; uropod 3 obliquely truncate and setose, inner ramus longer than outer.

Distribution: Indo-Pacific, west coast of South Africa.

Gammaropsis afra (Stebbing, 1888)

Eurystheus afer: K. H. Barnard, 1916: 249, pl. 28, fig. 11.

Gammaropsis afra: J. L. Barnard, 1970b: 170, fig. 108.

Records: IN 159 H (2).

Diagnosis: Eyes not lageniform; gnathopod 2 palm of two irregular humps, finely crenulate; otherwise resembling *G. atlantica*, of which it may eventually prove to be a variety.

Distribution: Indo-Pacific and eastern Atlantic Oceans.

Gammaropsis atlantica (Stebbing, 1888)

Eurystheus atlanticus: Stebbing, 1908: 86.

Gammaropsis atlantica: J. L. Barnard, 1970b: 174, figs 111–113.

Records: PED 2 M (1); PED 6 J (13); PED 8 Q (present); PED 10 S (15); PED 15 E (present).

Diagnosis: Cephalic lobes moderately projecting, eyes lageniform; accessory flagellum thin, six-articulate in adults; gnathopod 2 article 6 $1\frac{1}{2}$ times as long as broad, palm oblique with a large cavity near the defining angle and a bulge near the hinge.

Remarks: A highly variable species, especially as regards the eyes, which range from lageniform (in South African specimens) to oval. J. L. Barnard (1970b) discusses two phenotypes found in Hawaii and suggests that *G. atlantica* and *G. afra* (Stebbing) may form a single species complex.

Distribution: Eastern Atlantic and Indo-Pacific.

Gammaropsis inhaca n. sp.

Fig. 7

Diagnosis of male: Head equal to two pereon segments, ocular lobes extending half the length of article 1 of antenna 1; eyes oblique, oval, black.

Articles 1 and 3 of antenna 1 equal, shorter than article 2, flagellum fourteen-articulate and 70% the length of peduncle; antenna 2 slightly longer than antenna 1, article 2 produced distally, article 3 curved, flagellum thirteen-articulate.

Mandibular molar large, palp triarticulate, articles 2 and 3 equal, longer than article 1.

Coxa 1 acutely produced forwards to base of antenna 2, distal portion flared outwards; coxae 2–7 small, scarcely touching. Gnathopod 1, article 2 constricted near its origin, article 6 slightly larger than 5, setose on medial surface, palm oblique, a marked concavity near the hinge followed by a large

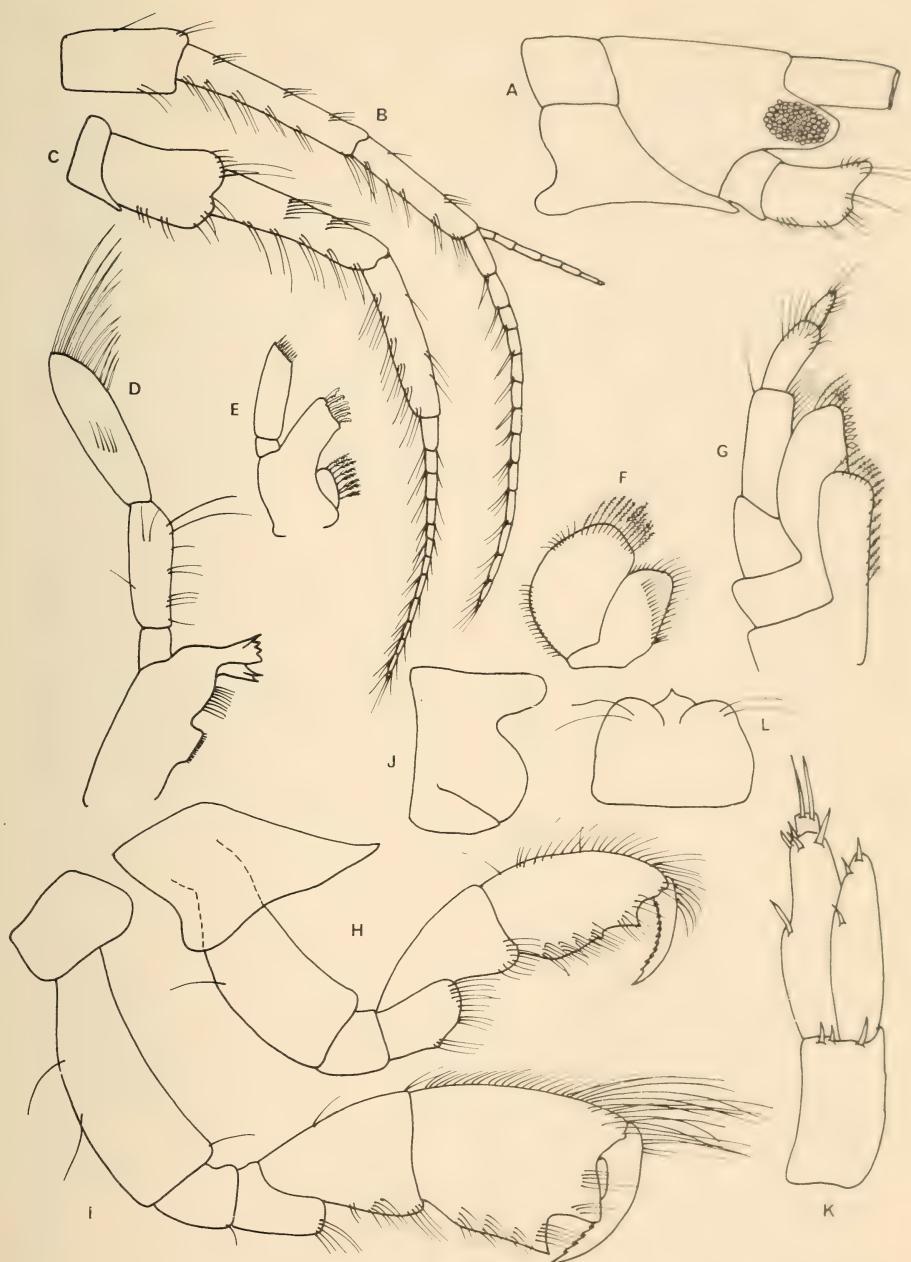


Fig. 7. *Gammaropsis inhaca* n. sp., holotype, male 7 mm.

A. Head. B. Antenna 1. C. Antenna 2. D. Mandible. E. Maxilla 1. F. Maxilla 2. G. Maxilliped.
H. Gnathopod 1. I. Gnathopod 2. J. Pleonal epimeron 3. K. Uropod. L. Telson.

tooth; remainder of palm concave, a small tooth at defining angle; dactyl cut into ten teeth, closing onto inner surface of article 6. Gnathopod 2 slightly larger than 1, inner surface of article 6 extremely setose, palm similar to that of gnathopod 1 but more exaggerated, dactyl with four teeth, closing onto inner surface of article 6.

Pereiopods 1 and 2 glandular; article 2 of pereiopods 3-5 not expanded.

Peduncle of uropod 1 with a large distal spine. Uropod 2 not extending beyond uropod 1, peduncle lacking spine. Rami of uropod 3 slightly longer than peduncle, outer ramus slightly exceeding inner, and having a small second article.

Telson quadrate, two subterminal setae on lateral lobes.

Posterior edge of third pleonal epimeron concave proximally, convex distally, postero-inferior corner faintly notched, a diagonal ridge running to the notch.

Colour (as preserved): White, a black area distally on article 2 of gnathopod 1 and of pereiopods 4 and 5.

Holotype: Male, 7 mm, unique. S.A.M. A 13068.

Type-locality: Recovered on intertidal mudflats off the west coast of Inhaca Island by biologists of the South African Museum, June 1971.

Records: IN 160 D.

Remarks: This species is easily distinguished from most others by the large teeth on the palms of gnathopod 1 and 2. Species with similar gnathopods are *G. setiferous*, which has a uniarticulate outer ramus to uropod 3, and *G. kergueleni*, which is probably the closest relative, but which differs in the structure of coxa 1 and by the lack of teeth on the dactyl of gnathopod 2.

Gammaropsis semichelatus (Barnard, 1957)

Eurytheus semichelatus K. H. Barnard, 1957: 8, Fig. 5.

Records: JAN 12 E (7); JAN 14 A (6); PEA 24 D (1).

Diagnosis: Article 2 of gnathopod 2 distally lobed, article 3 strongly lobed, article 6 elongate oblong, distally projecting forwards to form a chela with the short stout dactyl; third pleonal epimeron postero-inferiorly quadrate, minutely notched and with an oblique ridge running diagonally to the notch.

Distribution: Endemic to Natal and Moçambique.

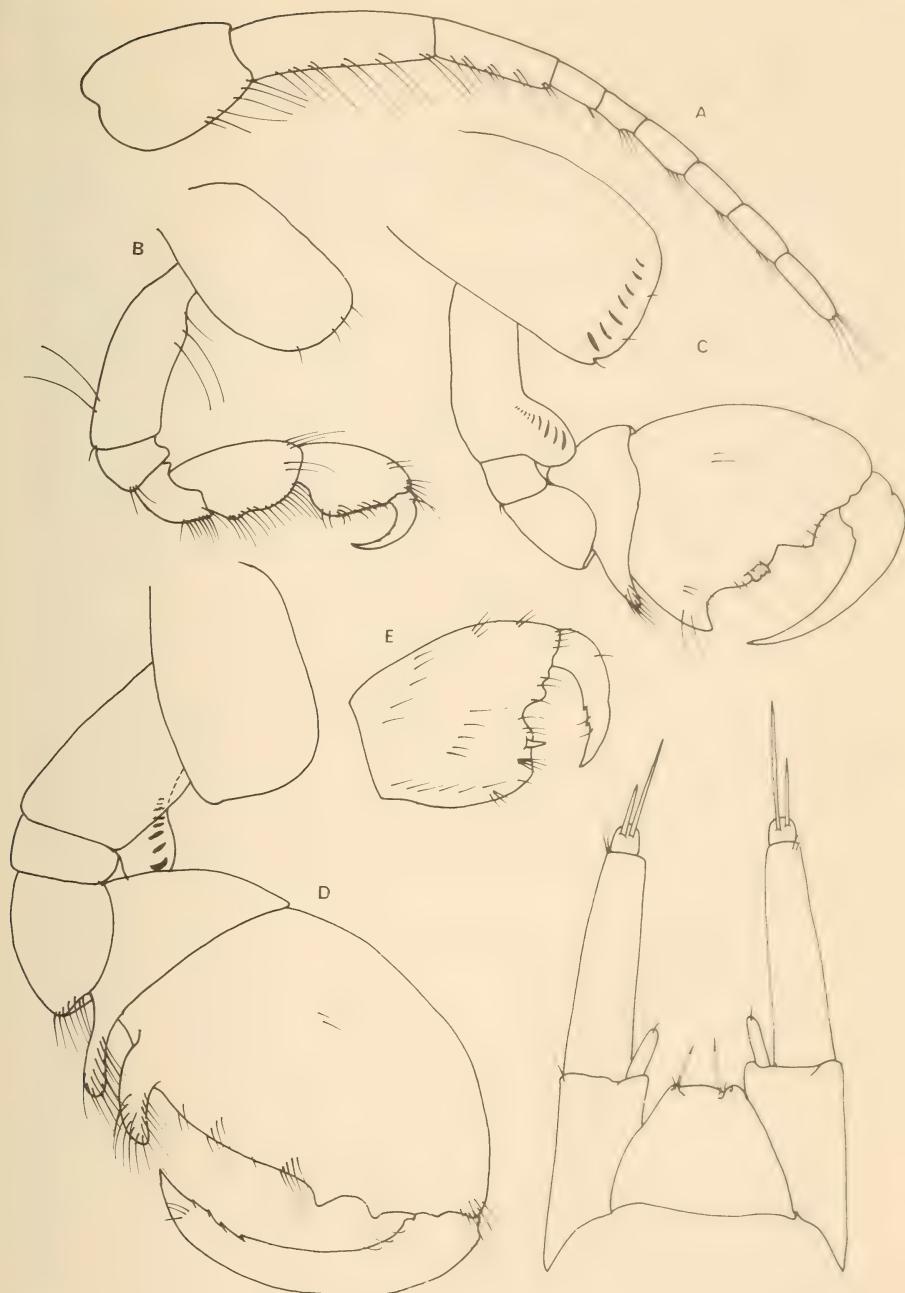
Photis kapapa Barnard, 1970

Fig. 8

Photis kapapa J. L. Barnard, 1970b: 192, figs 124, 125.

Records: MOR 244 A (15); PED 15 P (8).

Diagnosis: Article 2 of gnathopod 2 male distally produced into a large sacklike

Fig. 8. *Photis kapapa* Barnard

Male, 3 mm: A. Antenna 1. B. Gnathopod 1. C. Gnathopod 2. F. Uropod 3 and telson. Male, 5 mm: D. Gnathopod 2 (inner aspect). Female, 4 mm: E. Gnathopod 2.

lobe bearing stridulation ridges, article 5 cupshaped, with a tumid posterior lobe, article 6 variable, palm slightly to extremely oblique, defined by a large blunt tooth in young male which becomes an elongate curved process in terminal form, bisinuate between defining tooth and finger hinge. Coxae 2 to 4 and sometimes 1 bearing stridulation ridges.

Distribution: Hawaii, Moçambique. This is the first record of the species outside Hawaiian waters.

Remarks: Some of the males in the present collection are considerably larger (5 mm as compared with 2.5 mm) and have more highly developed gnathopods than those figured by Barnard (1970). In its terminal form (Fig. 8d) the palm of gnathopod 2 male is very oblique and the defining tooth has become enlarged into a curved lobe arising from the inner margin of the palm and curving distally and outwards. Small males however show gnathopods (Fig. 8c) very like those figured by Barnard and I have no hesitation in equating the present material with that from Hawaii, the only consistent differences being the length of the spines of uropod 3 and the number of segments of the flagellum of antenna 1 (6 as against 5 in Hawaiian specimens).

Family Leucothoidae

Leucothoe spinicarpa (Abildgaard, 1789)

Leucothoe spinicarpa: K. H. Barnard, 1916: 148. Sivaprakasam, 1967: 384, fig. 1.

Records: JAN 14 B (2); 'Portuguese East Africa' (K. H. Barnard 1955).

Diagnosis: Article 6 of gnathopod 1 finely crenulate and spinose, article 7 about half the length of 6; gnathopod 2, process of article 5 densely setose, article 6 massive, palm convex, minutely serrulate throughout; pleon segment 3 postero-inferiorly quadrate.

Remarks: A rather variable species. J. L. Barnard (1962) points out that in immature specimens article 3 of antenna 1 is longer in relation to articles 1 and 2 than in adults. In the past, this relationship has been used as an important taxonomic characteristic and the observation of differential growth may necessitate a taxonomic revision of the genus.

Distribution: Cosmopolitan.

Family Lysianassidae

Amaryllis macrophthalma Haswell, 1880

Amaryllis macrophthalma: K. H. Barnard, 1916: 114.

Records: PED 23 R (1); JAN 12 F (6); JAN 12 R (1); PEA 24 A (1).

Diagnosis: Eyes vertically elongate, subcrescentic; pleon segment 3 postero-inferiorly squarely upturned with a little pocket above the point; uropod 2 rami

subequal, the inner markedly constricted a third before the tip; telson extending beyond the peducle of uropod 3, more than 50% cleft, apices not divergent.

Distribution: Indo-Pacific, extending around the South African coast to South West Africa.

Aristias symbiotica Barnard, 1916

Aristias symbiotica K. H. Barnard, 1916: 122.

Records: PED 6 N (1).

Diagnosis: Eyes fairly large, oval to circular; third pleonal epimeron postero-inferiorly quadrate, hind margin finely serrulate; telson as broad as long, two-thirds cleft, each apex with a stout spine set in a notch; hind margins of article 2 of pereiopods 3 and 4 with three to four serrations, pereiopod 5 with six serrations; uropods with short spines at tips of their peduncles, rami minutely spinulose; uropod 3 rami lanceolate, inner longer than article 1 of outer.

Remarks: All the species of this genus lead a semi-parasitic existence in the branchial cavities of ascidians or sponges.

Distribution: Endemic, South West Africa to Moçambique.

Lysianassa cinghalensis (Stebbing, 1897)

Lysianassa cinghalensis: Ledoyer, 1968: 19, fig. 1.

Records: JAN 12 G (2); IN 159 E (2).

Diagnosis: Eyes large, dark, reniform; article 1 of antenna 1 twice as long and 1½ times as wide as articles 2 plus 3, accessory flagellum tri-articulate; gnathopod 1 simple; coxa 1 with a small setiferous notch on the lower margin; gnathopod 2 very long, article 2 as long as 4 to 6 combined; uropod 2 inner ramus moderately constricted; uropod 3 peduncle slightly keeled; telson entire and oval.

Distribution: Tropical Indian Ocean. This is the first record of this species from the southern African mainland.

Microlysius indica Barnard, 1937

Fig. 9

Microlysius indica K. H. Barnard, 1937: 144.

Records: MOR 102 M (1); MOR 122 T (2); MOR 138 G (1).

Diagnosis: Antenna 2 male half as long as body; article 4 very tumid; gnathopod 1 subchelate, article 6 longer than 5, 1.5 times as long as broad; gnathopod 2, article 5 widening distally, article 2 of pereiopods 3–5 feebly serrate.

Remarks: Barnard's original specimens were described as having an indistinct fourth article to the maxillipedal palp but the present specimens have a distinct, though small, fourth article.

Distribution: South Arabian coast, southern Africa.

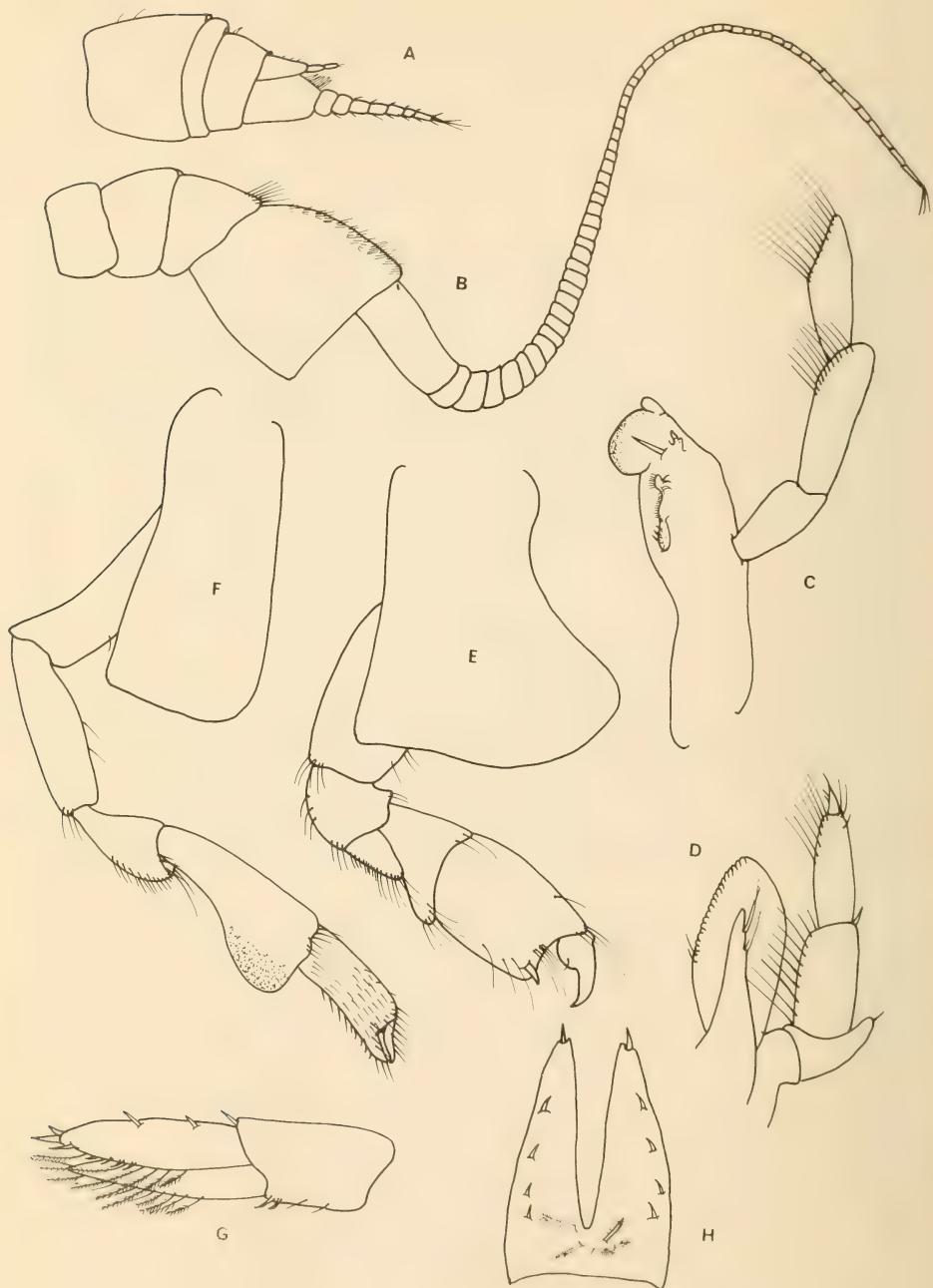


Fig. 9. *Microlysias indica* Barnard, male, 6 mm.

A. Antenna 1. B. Antenna 2. C. Mandible. D. Maxilliped. E. Gnathopod 1. F. Gnathopod 2.
G. Uropod 3. H. Telson.

Trischizostoma circulare Barnard, 1961

Trischizostoma circulare J. L. Barnard, 1961: 51, fig. 20.

Records: 25°36'S/35°21'E, 730 m.

Diagnosis: Article 6 of gnathopod 1 nearly circular, dactyl smooth; rostrum elongate; telson entire; article 6 of gnathopod 2 asymmetrical, distal end produced.

Distribution: The above record is the only one to date.

Trischizostoma sp.

Records: PED 23 T (1 juvenile).

Remarks: The characteristic powerful gnathopods of this individual identify it as a member of the genus *Trischizostoma*. The gnathopods were not, however, sufficiently developed to allow a specific identification. (*T. remipes* Stebbing, 1908 and *T. circulare* are the only species previously recorded from the east coast of Africa.)

Family **Oedicerotidae***Periocolodes longimanus* (Bate & Westwood, 1868)

Periocolodes longimanus: Chevreux & Fage, 1925: 162, figs 163, 164. Ledoyer, 1967: 127, fig. 7.

Records: PED 18 W (1).

Diagnosis: Rostral projection short, lateral corners rounded, eyes broadest dorsally, with about twelve lenses; gnathopods 1 and 2, process of article 5 to tip of article 6, article 6 three times as long as broad; rami of uropod 3 very narrow, unarmed; telson evenly rounded, twice as long as broad.

Distribution: Mediterranean, Atlantic, Indian Ocean.

Synchelidium haplocheles (Grube, 1864)

Synchelidium haplocheles: Sars, 1895: 318, pl. 112, fig. 1.

Records: MOR 212 K (1).

Diagnosis: Rostrum short, evenly curved; eyes large, round, bright red; process of article 5 of gnathopod 1 produced well beyond hind margin of article 6; article 6 medially widened, palm longer than hind margin and having six large, blunt denticles; gnathopod 2 slender, chela one-fifth the length of article 6.

Distribution: North Atlantic, Mediterranean, Ceylon, southern Africa.

Family **Phoxocephalidae***Metaphoxus* sp.

Fig. 10

Diagnosis: Rostrum longer than peduncle of antenna 1, evenly tapering, tip rounded. Eyes consisting of about 12 ocelli. Antenna 1 as long as head, flagellum ten-articulate, accessory flagellum eight-articulate. Antenna 2 equal to antenna 1.

Mandibular molar reduced to nine spines; mandibular palp with article 3 distally expanded. Maxilla 1 palp uniarticulate, inner lobe bearing three spines. Maxillipedal palp article 4 elongated, bearing a strong spine at its tip. Gnathopod 1 about half the size of gnathopod 2, palms of both gnathopods slightly oblique, convex, defined by a rounded convexity.

Pereiopod 1, article 2 with four long setae posteriorly, article 4 $1\frac{1}{2}$ times longer than broad, anteriorly slightly produced to overlap article 5; article 5 almost as broad as long; article 6 slender with six heavy spines along posterior margin, the last extending to the tip of the dactyl and comparable in width to it. (Pereiopods 2 and 3 are missing.)

Pereiopod 5, article 2 serrate posteriorly and anteriorly, article 4 with two fascicles of spines posteriorly. Second pleonal epimeron bearing a group of five plumose setae on its outer surface. Third pleonal epimeron quadrate.

Uropod 1, rami subequal. Uropod 2, peduncle with two dorsal and one terminal spine, inner ramus nearly twice as long as outer. Uropod 3 rami foliaceous, fringed with long plumose setae.

Material: A single damaged male, 10 mm, recovered in two portions such that pereiopods 3 and 4 were missing on both sides. Unique.

Records: PED 18 V (1).

Remarks: Distinguished from other members of the genus by the very long rostrum, the setae on the second pleonal epimeron, and the third uropods. The gnathopods resemble those of *M. simillimus* and *M. pectinatus* but the defining lobes are more rounded and not spinose.

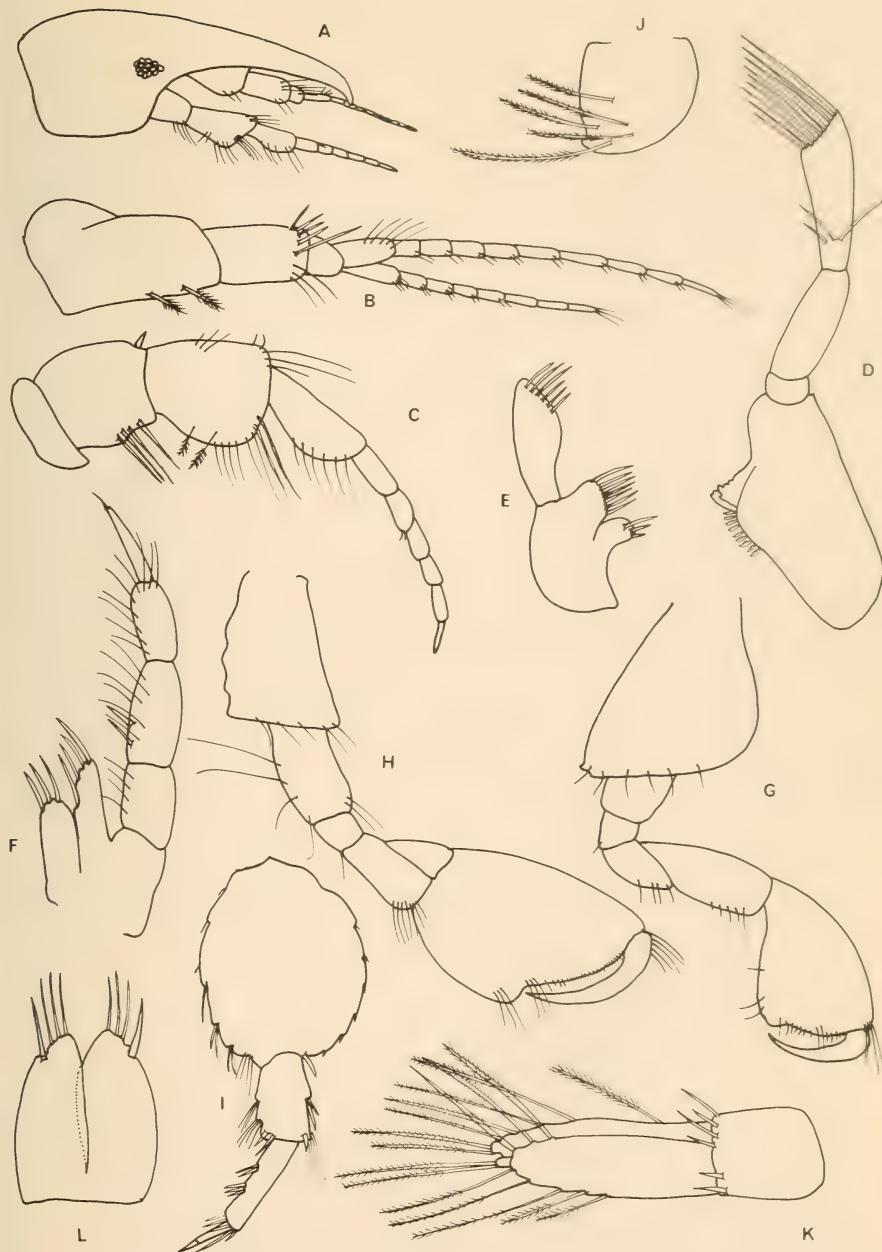
Family **Podoceridae***Laetmatophilus purus* Stebbing, 1888

Laetmatophilus purus Stebbing, 1888: 1198, pl. 132. K. H. Barnard, 1916: 274.

Records: MOR 243 Z (80).

Diagnosis: Article 2 of gnathopod 2 broad, channeled anteriorly, article 6 with palm long, undefined, a broad lobe near the hinge followed by a narrow blunt tooth; pereon transversely corrugated; articles 5 and 6 of gnathopod 1 subequal and setose, 6 abruptly widening at its base, dactyl toothed.

Distribution: Endemic, South West Africa to Morumbene.

Fig. 10. *Metaphoxus* sp., male, 10 mm.

A. Head. B. Antenna 1. C. Antenna 2. D. Mandible. E. Maxilla 1. F. Maxilliped. G. Gnathopod 1. H. Gnathopod 2. I. Pereiopod 5. J. Pleonal epimeron 2. K. Uropod 3. L. Telson.

Laetmatophilus tridens Barnard, 1916*Laetmatophilus tridens* K. H. Barnard, 1916: 275, pl. 28, fig. 22.*Records*: PED 10 Q (1).

Diagnosis: Pereon segments 2–4 with small medio-dorsal tubercles; dactyl of gnathopod 1 very thick and very convex, distally cut into ten closely-set spine-teeth; article 2 of gnathopod 2 with two anterior keels, one ending acutely, the other subacutely, palm setose, distally bearing three teeth, that closest to the hinge triangular, the second cylindrical and the third broad and denticulate.

Distribution: Endemic, Saldanha Bay to Moçambique.*Podocerus cristatus* (Thompson, 1879)*Podocerus cristatus*: K. H. Barnard, 1916: 276. J. L. Barnard, 1962: 67, fig. 31.*Records*: PED 15 G (4).

Diagnosis: Pereon segments 6 and 7 and pleon segments 1 and 2 medio-dorsally carinate (on large specimens small carinae may also appear on segments 5 or even 4 and 3); gnathopod 2 palm bearing a denticulate lobe near the hinge followed by a conical tooth.

Distribution: Cosmopolitan in tropical and warm-temperate seas.*Podocerus inconspicuus* (Stebbing, 1888)*Podocerus palinuri* K. H. Barnard, 1916: 277, pl. 28, fig. 23.*Podocerus inconspicuus*: Pirlot, 1938: 356, fig. 160.*Records*: PED 16 W (1).

Diagnosis: Head with a low rounded dorsal keel; pereon segments 1–7 and pleon segments 1 and 2 dorsally carinate; gnathopod 2 male with palm bearing a flat tooth near the hinge and a small conical one below it.

Distribution: Indian Ocean and west coast of South Africa.Family **Stenothoidae***Stenothoe gallensis* Walker, 1904*Stenothoe gallensis*: K. H. Barnard, 1916: 154; 1925: 344. J. L. Barnard, 1955: 3 fig. 1.*Records*: JAN 12 S (2).

Diagnosis: Gnathopod 2 male with hind margin of article 4 finely crenulate, palm straight, densely hirsute, a double tooth near base of dactylus; uropod 3 uniramous, ramus bi-articulate and slightly shorter than peduncle, article 2 curved upwards, finely denticulate dorsally.

Distribution: Mediterranean, Caribbean, Hawaii, Indian Ocean.

Stenothoe valida Dana, 1853

Stenothoe affinis: K. H. Barnard, 1925: 345.

Stenothoe valida: Ledoyer, 1967: 125, fig. 4b. Sivaprakasam, 1967: 373, fig. 2a-b.

Records: JAN 12 Q (1); Cabo da Inhaca (Kalk 1958).

Diagnosis: Gnathopod 2 male with the hind margin of article 4 entire, palm slightly concave, a large, distally directed tooth and a marked incision near the base of the dactylus; uropod 3, article 2 of ramus straight, not denticulate.

Distribution: Cosmopolitan in tropical and temperate seas.

Superfamily TALITROIDEA

Family **Hyalidae***Hyale grandicornis* Kröyer, 1845

Hyale grandicornis: K. H. Barnard, 1916: 230. Stephensen, 1949: 33, figs 14-15. K. H. Barnard, 1955: 93, fig. 46.

Records: Among seaweeds on the east coast of Inhaca Island (Macnae & Kalk, 1958).

Diagnosis: Eyes large, nearly meeting on top of the head; gnathopod 2 article 2 not lobed, article 3 with a small lobe, palm of male oblique, with a pocket-like cavity and a double tubercle carrying two spines defining it from a fairly long hind margin.

Remarks: *Hyale grandicornis* Kröyer and *Hyale novaezealandia* (Thompson) were at one stage separated by differences in spination of uropods 1 and 2 and pereiopod 4. K. H. Barnard (1916) found that these characters were not consistently correlated in different populations and united the species. Apparently, one of the several forms predominates in any one population to the almost complete exclusion of the other forms. Hurley (1957) suggests that environmental factors determine the genetic balance achieved by different populations.

Distribution: Indo-Pacific, Tristan da Cunha, South West Africa, Gough Island.

Parhyale inyacka (Barnard, 1916)

Hyale inyacka K. H. Barnard, 1916: 233, pl. 23, fig. 4.

Parhyale inyacka: J. L. Barnard, 1955: 23, fig. 12. Sivaprakasam, 1969b: 562, fig. 6.

Records: IN 159 B (1); MOR 40 Z (18); MOR 75 A (11); MOR 232 D (3).

Diagnosis: Antenna 2 half body length, twice as long as antenna 1; gnathopod 2 male with article 6 elongate-oval, palm oblique, convex; pereiopod 3 with hind margin of article 2 serrate, a marked indent centrally; article 6 of pereiopods 4 and 5 spinose posteriorly; peduncle of uropod 3 slightly longer than outer ramus, inner ramus small but distinct.

Remarks: Shoemaker (1956), in a review of the genus, united *P. inyacka* (Barnard) with *Hyale hawaiensis* (Dana) but this has not been accepted by Bulycheva (1957) or Sivaprakasam (1969b).

Distribution: Cosmopolitan in warm-temperate and tropical seas.

Family **Talitridae**

Orchestia ancheidos (Barnard, 1916)

Talorchestia ancheidos: K. H. Barnard, 1916: 221, pl. 27, figs 35–36; 1940: 470, fig. 31.

Records: MOR 179 A (5); MOR 180 A (abundant); MOR 193 A (1); POE 8 A (common); Masiene (near Limpopo River mouth) (Barnard 1940).

Diagnosis: Eyes separated by less than their diameter; coxa 2 with a strong rounded lobe on upper posterior edge; gnathopod 1 male, article 5 strongly expanded distally and longer than subtriangular article 6; gnathopod 2 male, article 6 oval, widest at its midpoint, palm convex, spinose, forming an almost even curve with hind margin, dactyl strongly curved.

Distribution: Malagasy, Moçambique, South Africa.

Orchestia anomala Chevreux, 1901

Talorchestia malayensis: K. H. Barnard, 1955: 93.

Orchestia anomala: Sivaprakasam, 1969a: 297, fig. 1.

Records: Among *Botrychia* on intertidal rock faces, west coast of Inhaca and along drift line, Northern Bay (Macnae & Kalk, 1962).

Diagnosis: Articles 4–6 of gnathopod 1 male with scabrous lobes; dactyl of gnathopod 2 male with averted point; hind margin of article 2 of pereiopod 5 with numerous serrations, pleonal epimera 2 and 3 with submarginal ridges.

Remarks: K. H. Barnard (1935) united *T. malayensis* Tattersall with his *Orchestia floresiana*, which were synonymized with *O. anomala* Chevreux by Schellenberg (1938). Barnard again, however, recorded *T. malayensis* as a distinct species in 1955. The synonymy established by Schellenberg is nevertheless generally accepted since *T. malayensis* shows a palm in the female gnathopod 1.

Distribution: Indo-Pacific.

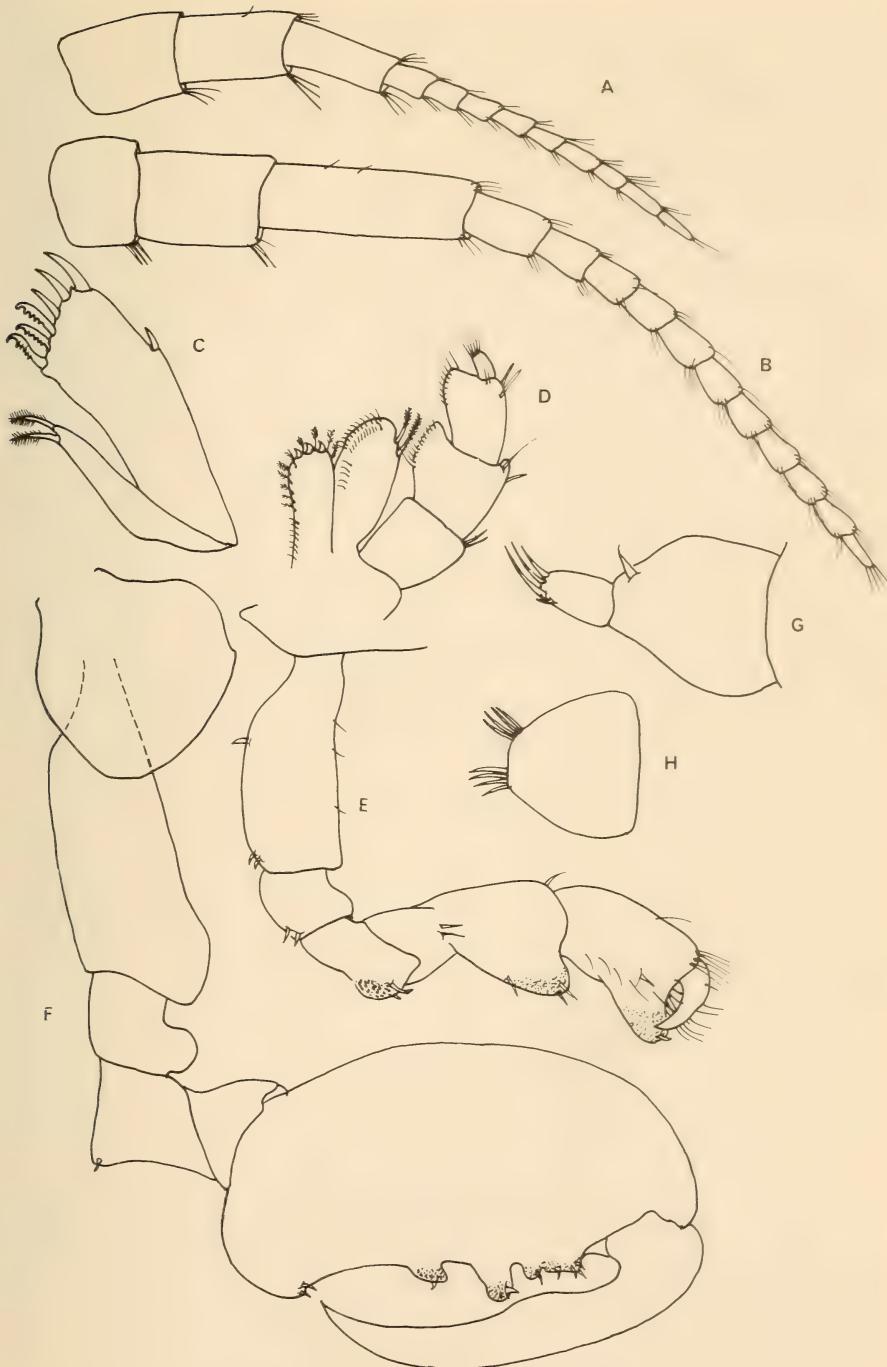
Orchestia notabilis (Barnard, 1935)

Fig. 11.

Parorchestia notabilis K. H. Barnard, 1935: 291, fig. 8.

Records: MOR 85 B (6); MOR 95 C (4).

Diagnosis: Gnathopod 2 male strongly developed, article 6 ovate, the straight palm separated from the hind margin by a slight step, one conical tooth in the

Fig. 11. *Orchestia notabilis* (Barnard), male, 9 mm.

A. Antenna 1. B. Antenna 2. C. Maxilla 1. D. Maxilliped. E. Gnathopod 1. F. Gnathopod 2.
G. Uropod 3, lateral view. H. Telson.

centre of the palm, a slightly larger one distally and two small rounded projections between the latter and the hinge; inner margin of dactyl sinuous, tip not averted; pereiopod 5, article 2 with slight and widely spread setiferous indent.

Distribution: India, Moçambique.

Talorchestia australis Barnard, 1916

Talorchestia australis K. H. Barnard, 1916: 220, pl. 27, figs 33–34; 1940: 470, fig. 30.

Records: MOR 250 F (2); MOR 255 F (1); IN 159 F (fairly common).

Diagnosis: Eyes distance apart equal to diameter; coxa 2 not lobed posteriorly; gnathopod 1 male, article 5 triangular with a prominent apical lobe, longer than article 6, article 6 not strongly expanded, apically lobed, palm concave; article 6 of gnathopod 2 male oblong, widest across the defining angle, palm nearly transverse, slightly convex, a small pellucid lobe at palmar angle, spinose, dactyl matching palm, evenly curved.

Distribution: Endemic, South West Africa to Moçambique.

Suborder CAPRELLIDEA

Family **Aeginellidae**

Metaprotella haswelliana (Mayer, 1882)

Metaprotella haswelliana: Sundara Raj, 1927: 126, pl. 16. McCain & Steinberg, 1970: 54.

Records: MOR 212 J (3).

Diagnosis: Last two thoracic segments fused, segment 5 long and slender; pereiopods 1 and 2 almost as long as branchiae; dorsal surface of head and body spinose; article 1 of antenna 1 bearing a small tubercle with 1 seta.

Distribution: Indo-Pacific.

Monoliropus falcimanus Mayer, 1904

Monoliropus falcimanus: Sivaprakasam, 1967: 382, fig. 4g–h. McCain & Steinberg, 1970: 56.

Records: PED 7 N (1); PED 20 U (4).

Diagnosis: Hand of gnathopod 2 male long, slender, sickle-shaped, the palmar edge covered by long setae; basis of gnathopod 2 slender with lateral ridges, longer than pereon segment 2; branchiae long and slender; pereiopods 1 and 2 very small; penultimate joint of maxillipedal palp produced into a pointed process; flagellum of antenna 1 nine-articulate in male and eight-articulate in female.

Distribution: Ceylon, India, Moçambique. This is the first record from Africa.

Orthoprotella mayeri Barnard, 1916

Orthoprotella mayeri K. H. Barnard, 1916: 284; 1925: 372. McCain & Steinberg, 1970: 57.

Records: PED 8 N (4); PED 15 S (3); PED 20 T (5); on the hydroid *Lytocarpus philippinus* on Inhaca Island (Macnae & Kalk, 1958).

Diagnosis: Young specimens smooth, but those over 10 mm with lateral spines on the anterior margins of segment 2 and above the base of gnathopod 2; segment 3 also with antero-lateral spines and a pair of dorsal tubercles; gnathopod 2 with palm sparingly setose, a single triangular tooth near the finger hinge with a narrow parallel-sided slit cut in the apex and extending nearly to the basal line; pereiopods 1 and 2 half as long as branchiae, uniarticulate, apically setose.

Distribution: Indo-Pacific.

Family **Caprellidae***Caprella equilibra* Say, 1818

Caprella equilibra: McCain, 1968: 25–30, figs 12–13. McCain & Steinberg, 1970: 19.

Records: JAN 12 L (18).

Diagnosis: Basis of gnathopod 2 less than half the length of pereon segment 2; a spine between the insertions; palm very oblique, defined by a small tooth and with a large rectangular tooth distally; large males with very elongate pereon segment 2 and peduncular articles of antenna 1 enlarged.

Distribution: Cosmopolitan, 0–300 m.

Caprella scaura Templeton, 1836

Caprella scaura: K. H. Barnard, 1925: 371. McCain, 1968: 40–44, figs 17–18. McCain & Steinberg, 1970: 37.

Records: On *Cymodocea*, Inhaca Island (Macnae & Kalk, 1958).

Diagnosis: Large, anteriorly-directed cephalic spine; pereon segments 1–2 male elongate, basis of gnathopod 2 equal to pereon segment 2; gnathopod 2 male with hand elongate, palm with two teeth and a distal rectangular projection.

Remarks: K. H. Barnard (1925) amalgamated *C. laevipes* Mayer with *C. scaura* but this synonymy has not been followed, since *C. laevipes* does not bear grasping spines on the pereiopods.

Distribution: Cosmopolitan.

Hemiaegina minuta Mayer, 1890

Hemiaegina minuta: McCain, 1968: 61–64, figs 29–30. McCain & Steinberg, 1970: 51.

Records: JAN 14 C (1).

Diagnosis: Flagellum of antenna 2 bi-articulate; mandibular palp absent, molar present; in dorsal view, pereonites centrally expanded; pereiopods 1 and 2 uniarticulate; a pair of ventral spines between the insertions of gnathopod 2.

Distribution: Cosmopolitan in warm and temperate seas.

Family **Phtisicidae***Phtisica marina* (Slabber, 1769)

Phtisica marina: K. H. Barnard, 1916: 283. McCain, 1968: 91–97, fig. 46. McCain & Steinberg 1970: 64.

Records: PED 15 R (1).

Diagnosis: Head anteriorly rounded; gnathopod 1 male, hand subtriangular, palm very oblique, defined by a projecting lobe armed with several spines; gnathopod 2 male, carpus shorter than merus, hand widest proximally, palm defined by two grasping spines, otherwise lacking teeth; pereiopods 1 and 2 six-segmented.

Distribution: Atlantic, extending into the Mediterranean and Black Sea, and around southern Africa as far as Moçambique.

SUMMARY

A synthesis is presented of the known gammaridean and caprellid amphipod fauna of Moçambique south of 20°S. Material was collected by the University of Cape Town and the South African Museum, reference also being made to specimens collected by the University of the Witwatersrand. Samples were taken at Morrumbene estuary, Inhaca Island, Jangamo reef, Maxixe, Lagoa Poelela, Ponta Zavora and by dredging to depths up to 135 m, a total of 65 species being recovered. One genus *Janice*, and three species, namely *Gitanopsis mariae*, *Janice spinidactyla* and *Gammaropsis inhaca* are described as new to science. Five others, namely *Paragrubia vorax* Chevreux, *Photis kapapa* Barnard, *Lyssianassa cinghalensis* (Stebbing), *Monoliropus falcimanus* Mayer and *Maera serrata* Schellenberg, are new records for southern Africa (here defined as Africa south of 20°S).

Brief diagnoses, references and distributions are given for each species.

ACKNOWLEDGEMENTS

I wish to express my thanks to Professor J. H. Day for his advice and encouragement; also to Dr J. C. McCain for his identification of *Monoliropus falcimanus* and to Brian Kensley of the South African Museum for the supply of specimens from Inhaca and Ponta Zavora.

I am also indebted to J. Laurens Barnard, J. C. McCain, T. E. Sivaprakasam, M. Ledoyer, Wim Vader, Margaret Kalk and others for literature and unpublished information.

Financial support was provided by the South African Council for Scientific and Industrial Research.

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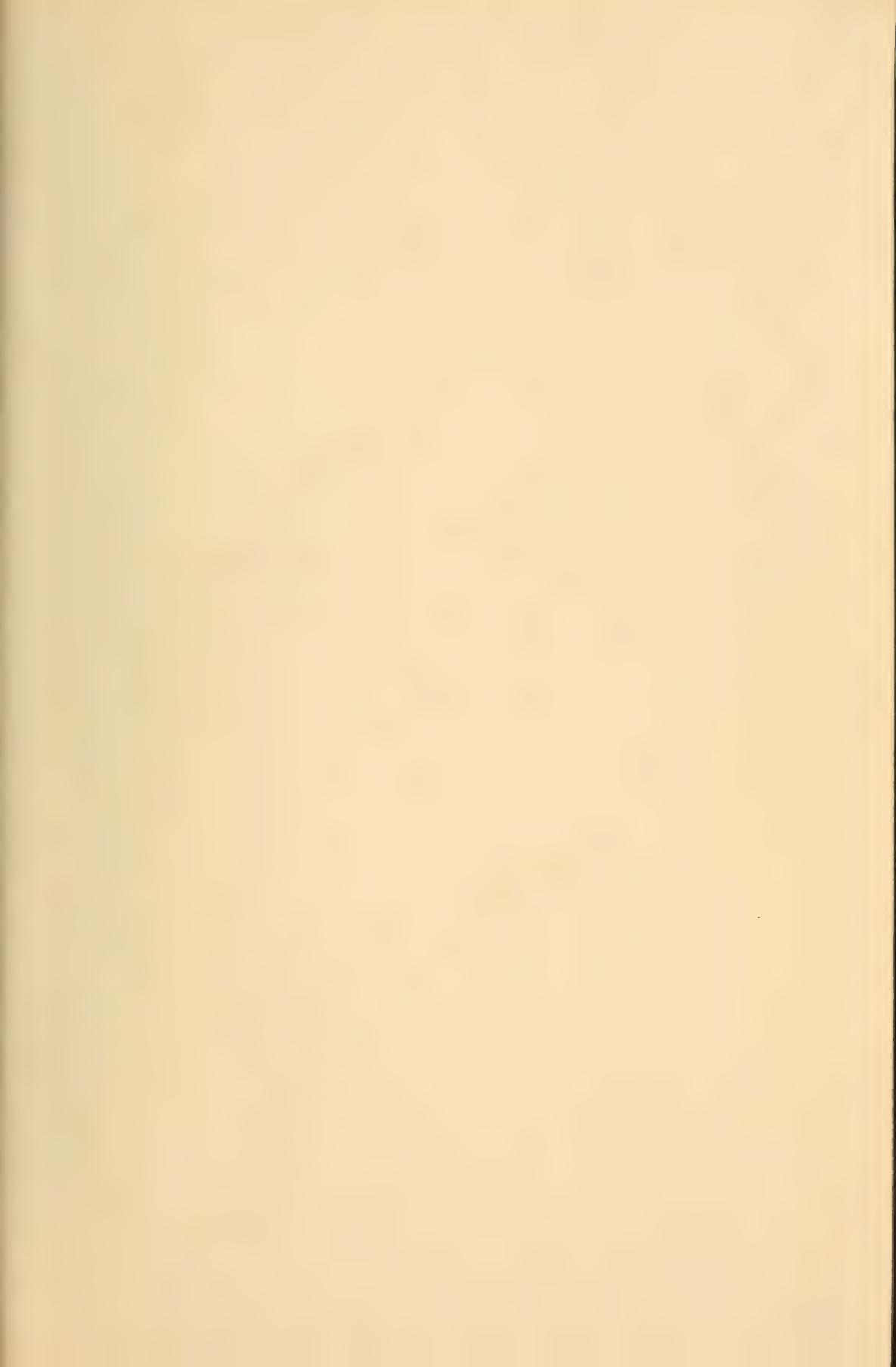
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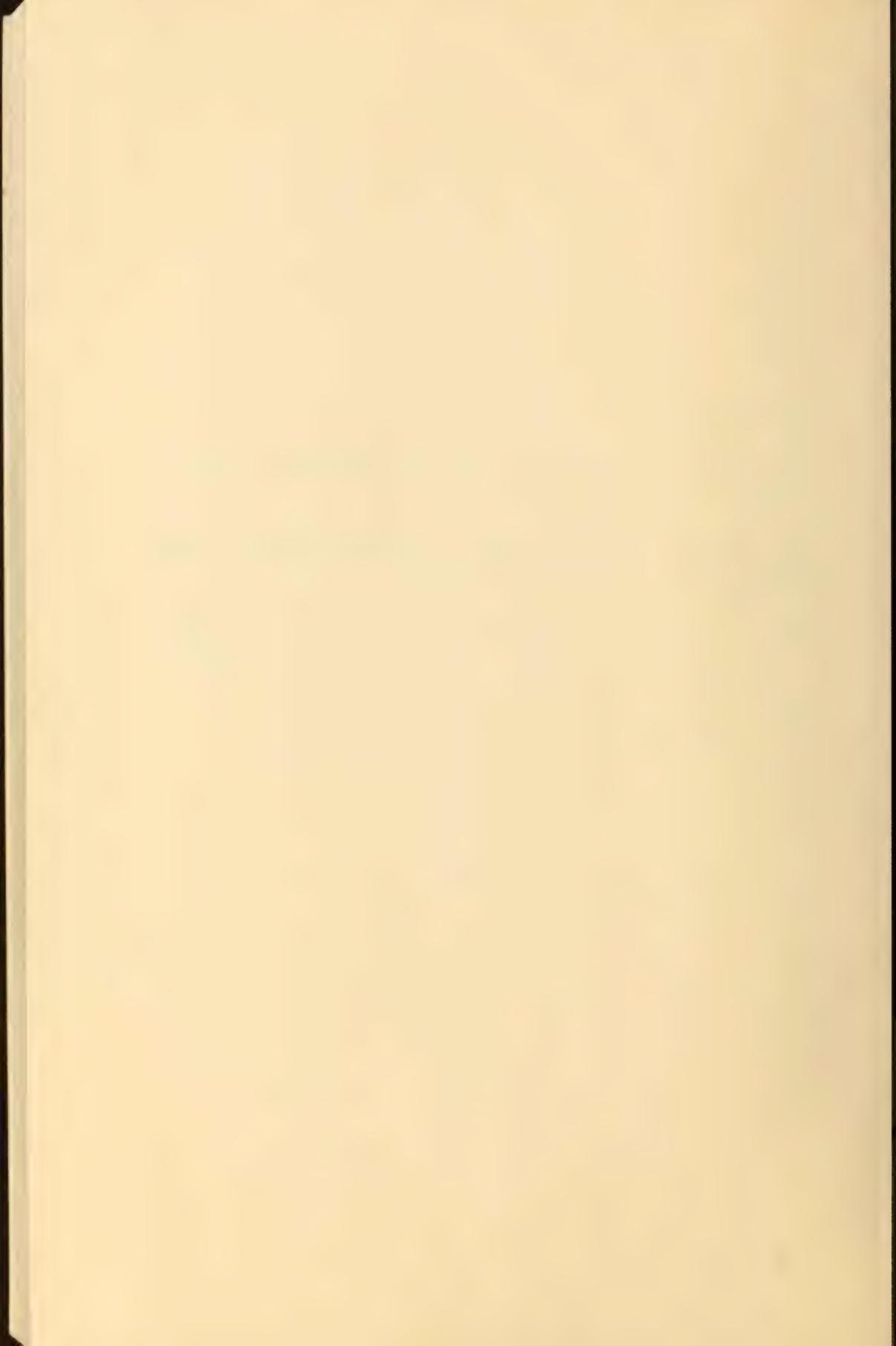
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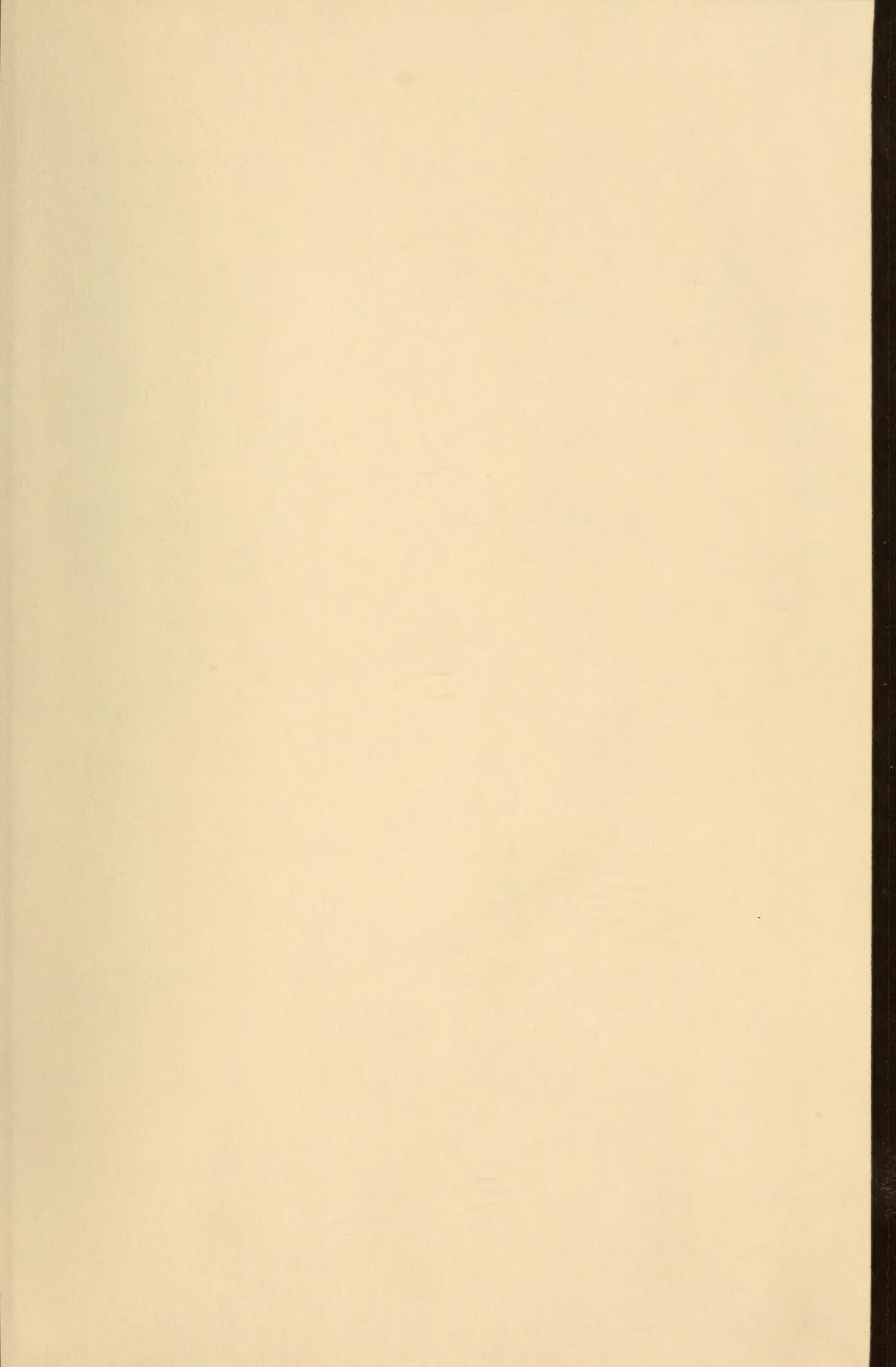
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