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

Volume 92 Band
February 1984 Februarie
Part 4 Deel

MORPHOLOGICAL AND BIOLOGICAL NOTES ON SOME SOUTH AFRICAN ARTHROPODS ASSOCIATED WITH DECAYING ORGANIC MATTER

PART 2

THE PREDATORY FAMILIES CARABIDAE, HYDROPHILIDAE, HISTERIDAE, STAPHYLINIDAE AND SILPHIDAE (COLEOPTERA)

By

A. J. PRINS

Cape Town Kaapstad

MORPHOLOGICAL AND BIOLOGICAL NOTES ON SOME SOUTH AFRICAN ARTHROPODS ASSOCIATED WITH DECAYING ORGANIC MATTER

PART 2

THE PREDATORY FAMILIES CARABIDAE, HYDROPHILIDAE, HISTERIDAE, STAPHYLINIDAE AND SILPHIDAE (COLEOPTERA)

By

A. J. PRINS

South African Museum, Cape Town

(With 16 figures)

[*MS accepted 16 June 1983*]

ABSTRACT

The morphology of the immature stages of fourteen species of beetles belonging to the families Carabidae, Hydrophilidae, Histeridae, Staphylinidae, and Silphidae, as collected along a narrow strip between Mossel Bay and Elands Bay and in a small area around Laingsburg and Tulbagh, is illustrated. Available data on their biology and ecology are given and their association with decaying organic matter is noted. These insects play an important part in the predation of the arthropods attracted to carcasses and cadavers and other decaying organic matter.

CONTENTS

Ann. S. Afr. Mus. **92** (4), 1984: 295–356, 16 figs.

INTRODUCTION

In the first part of this series of papers some specimens belonging to the myriapods, arachnids, crustaceans, and hemimetabolous hexapods are dealt with; in this second part the immature stages of the first group of the holometabolous families are considered.

This group comprises one species of the adephagous Coleoptera and thirteen species of the polyphagous series Staphyliniformia, which includes the superfamilies Hydrophiloidea, Histeroidea, and Staphylinoidea.

The surveys covered the beach, the dune system and the adjacent inland area along a narrow strip of the southern and western coastal regions of South Africa; a small strip between Laingsburg and Beaufort West, as well as between Worcester and Tulbagh, was also included.

Nearly half of all known insects are beetles and, although they are of such diverse form and habits and include some of the largest and also some of the smallest of insects, only a very few of them have developed a tendency to sociality. Of the some 150 known families only about nine show some signs of subsocial behaviour and these include the Staphylinidae, Silphidae, Hydrophilidae, and also the Scarabaeidae. However, none of the South African species or, at least, those that have been collected during the surveys, can be regarded as subsocial, except perhaps hydrophilids belonging to the genus *Spercheus*; some may well be described as gregarious as in the case of *Harpalus capicola* Dejean and *H. agilis* Péringuey (Carabidae); *Gonocephalum arenarium* (Fabricius), *G. simplex* (Fabricius), *Zophosis boei* Solier, and *Stenocara longipes* (Olivier) (Tenebrionidae), and various other species often collected in very large numbers under semi-dry to dry cow-pats, such as the vegetable weevil, *Listroderes costirostris* Schönherr (Curculionidae).

All the species discussed in this paper are geophiles and all are predacious both in the adult and larval stage, except the hydrophilids, the adults of which are coprophages. All are attracted to decaying organic matter in which other arthropods are breeding, and therefore play an important part in reducing the number of coprophagous species. Nevertheless, they will feed on the colloids oozing from the decaying matter if circumstances necessitate this, particularly the hydrophilids and silphids and, to a certain extent, the staphylinids.

The larvae of most species are campodeiform, and in the case of the Sphaeridiinae the legs are reduced and they resemble the scarabaeoid forms.

As the amount of food available plays an important part in the development of these insects, and as this food source is often limited, dwarfed individuals are common in nature, sometimes differing markedly from the normal forms. This is clearly demonstrated by some specimens of an unidentified species of *Philonthus* (Fig. 1B) collected in various localities during the survey and included here in the discussion on the Staphylinidae. To the naked eye the adults appeared to be two different species; however, there were no morphological

differences when the larvae were examined under the microscope and it is therefore assumed that they are variants of the same species.

The morphological terms used in this paper in the descriptions of the immature stages are those of Richmond (1920), Böving & Craighead (1931), Hafez (1939*a–d*), Dorsey (1940), Van Emden (1942), and Kasule (1968).

MORPHOLOGICAL AND BIOLOGICAL NOTES

Family **Carabidae**

Flat to oval, usually dark-coloured beetles with the thorax generally narrower than the elytra, except in certain groups such as the tribe Scaritini. Head narrower than pronotum and tarsi five-segmented. Antennae eleven-segmented. Wings well developed or absent.

The ground beetles can be divided into species that live near or in water, on the ground and in trees; of these groups the geophiles are the most abundant, the vast majority of which belongs to the subfamilies Carabinae and Harpalinae. The eggs of the different species are laid either in the soil or in little mud packets and there are three larval stages. Pupation usually occurs in the soil in a pupal cell.

Certain species are commonly found under kelp strings and flakes just above the highwater mark, such as the black *Acanthoscelis ruficornis* (Fabricius) (Fig. 2B), which was on various occasions excavated from the burrows of the isopod *Tylos capensis* Krauss and was also observed to feed on beach-fleas (*Orchestia* and *Talorchestia* spp.), fly maggots, and even on the ladybird *Lioadalia flavomaculata* de Geer, which is often found on the kelp. It was now and then collected from dead sea-birds. When feeding, the prey is held between the forelegs, and in the case of maggots almost everything is consumed except the mouth-hooks and a few pieces of the skin. Its food included the smaller, pale, straw-coloured cicindelid, *Platychila pallida* (Fabricius) (Fig. 2G), which occurred under similar conditions. This tiger beetle seems to favour the more arid parts of the north-western Cape Province.

Scarites rugosus Wiedemann (Fig. 2A) closely resembles *A. ruficornis*, but is much larger (30 mm) and has a wider distribution in South Africa, both along the coast and inland. Péringuey's (1896) note that it is generally found on the sea-shore, or at no great distance inland, is therefore not entirely correct. It was often found in the sand under shore plants; otherwise its habits are unknown.

Various other carabids have been collected in decaying and dry kelp, mostly of the flake and string types, of which *Harpalodes xanthorhaphus* (Wiedemann), *Harpalus fuscoaeneus* Dejean, *Tetragonoderus immaculatus* LaFerté, *Agonum rufipes* (Dejean), and *Liamegalonychus* spp. (Fig. 1D) were the most common. The first two species are widely distributed in South Africa and, together with *Liamegalonychus* (which also feeds on the flesh-fly *Sarcophaga maritima* Engel) have often been collected under cow-pats. *Hystrichopus vigilans* (Sturm), which resembles *Liamegalonychus* spp. and sometimes occurs in manure in the western Cape Province, has been found by the author to cause mild

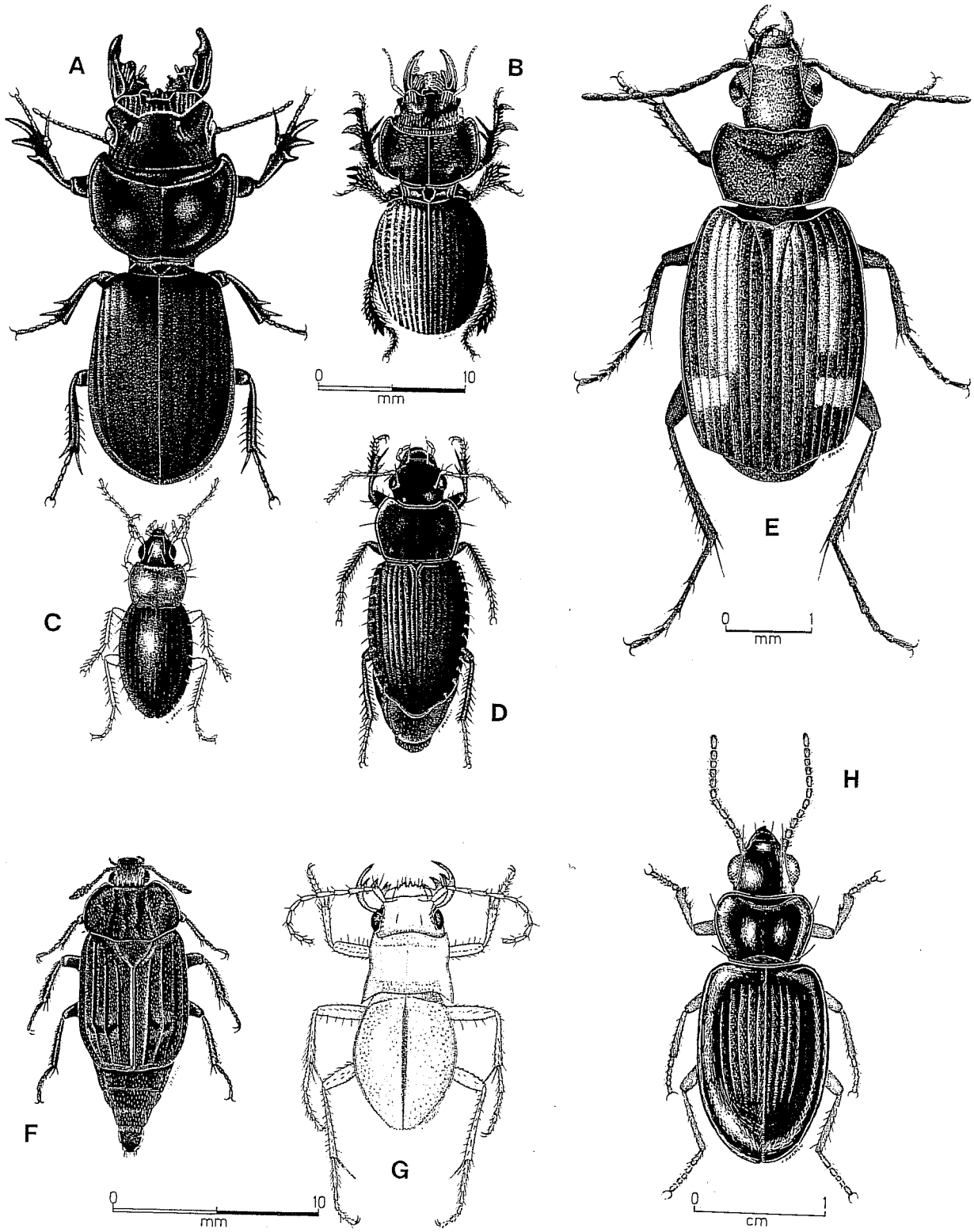

Fig. 2. Families Carabidae, Cicindelidae, Silphidae.
A. *Scarites rugosus* (adult). B. *Acanthoscelis ruficornis* (adult). C. *Geobaenus lateralis* (adult). D. *Harpalus capicola* (adult). E. *Tetragonoderus thunbergi* (adult). F. *Silpha mutilata* (adult). G. *Platychila pallida* (adult). H. *Thachys capicola* (adult).

BIOLOGY

Both adults and larvae are predacious and feed on various insects in the soil; those collected from the carcasses fed in the laboratory mainly on fly larvae and the grubs of skin-and-hide beetles. The maggots and pupae of the cheese skipper, *Piophila megastigmata* McAlpine, also seemed to be a favoured source of nourishment, as well as the caterpillars of tineids.

Beetles with fully developed eggs were collected under carcasses during April and May. These eggs (Fig. 3N) measure 1,6 mm × 0,88 mm and are oval shaped, almost pure white, with the surface microscopically wrinkled or shagreened and somewhat dull. Some beetles were found hibernating under the bark of trees and under stones; those collected during September survived for at least 6 months and bred larvae during the early winter. Full-grown larvae appeared from September to October and pupae were found from October to November. There was only one generation a year during the survey period; however, overlapping occurs and young larvae measuring 4,5 mm were observed during spring. The fully mature larvae construct clay cells in which they remain dormant for a short period (3–20 days) after which they pupate. Pupal stages varied from 11 to 13 days in the laboratory during the late spring and early summer (21–23 °C).

Newly emerged beetles are pale whitish brown, but after about a day the head and thorax become blackish; some 3 days later they usually assume their normal black colour.

Family **Hydrophilidae**

Small to medium-sized oval beetles, the dorsum smooth and convex, and the head prominent. Maxillary palpi fairly long and antennae seven to ten-segmented. Tarsal formula 5–5–5 or 5–4–4. Wings well developed.

Some seventy species have been described from southern Africa, most of which are aquatic or at least semi-aquatic; those of the subfamily Sphaeridiinae are terrestrial, restricted to wet or damp places and breed in dung and other decaying matter; larval breathing in this case is pseudometapneustic. Very little is known about the habits of one genus, *Coelostoma*; according to Böving & Henriksen (1938) the presence of suckers on the underside of the abdomen of the larvae may indicate that they are adapted for moving over rough or hard surfaces such as rotten leaves, etc. Adults of *Coelostoma punctulatum* (Klug) were collected on the green algae growing in stagnant pools in the vicinity of Laingsburg.

At least six species of water scavenger-beetles belonging to the above-mentioned subfamily are common in fresh cow-pats in the areas surveyed. When the dung starts to dry out, however, some of these beetles, together with some of the histerids and staphylinids, which are attracted, generally leave the pats, except those that prefer the drier media. The mandibles of the adult beetles are much better sclerotized than in the coprophagous *Aphodius* species (Scarabaeidae) and they are thus adapted to feed on much drier and harder dung particles,

and predation may not be entirely excluded. Most of these beetles therefore remain in the dung much longer than the smaller scarabs and are often found in fairly dry pats.

Cercyon maritimus Knisch was the most common species found in dung. In Mamre (south-western Cape) quite a large number of the rather small Palaearctic and Nearctic hydrophilid *Cercyon pygmaeus* (Illiger) occurred in association with *C. maritimus* during the early spring, but its larvae could not be traced. It was fairly abundant along the south coast during the late summer and autumn in both semi-fresh and almost dry cow-dung.

Sphaeridium caffrum Laporte & Castelnau appeared in large numbers during the winter and spring in the western parts of the Cape and was very numerous during the late summer when larvae and pupae were present in fresh dung in almost all areas. The related *S. quinquemaculatum* Fabricius (length about 3 mm), which is similar to, but smaller than, *S. caffrum* occurred during the summer in Montagu. It is widespread, not only in the Cape Province but also in other parts of the world such as Sri Lanka, southern Asia, China, and Taiwan (Knisch 1924*b*). *Sphaeridium caffrum*, however, is known only from the Subsaharan and Malagasy regions.

Pachysternum capense (Mulsant), on the other hand, which is also small (2,3–2,5 mm long), occurred in fair numbers together with *Sphaeridium quinquemaculatum* in Montagu and can be distinguished from the latter by having inconspicuous longitudinal striae on the elytra. It was common in the Karoo and along the west coast, often in association with *S. caffrum*. In the Sandveld an unidentified species (2,3–3,1 mm long), with blackish head and pronotum and pale straw-coloured elytra, appeared with *P. capense* in the same cow-pats.

Cercyon maritimus and *C. gigas* d'Orchymont usually also breed in decaying kelp and may even be found in the decaying carcasses of marine animals and birds. According to collection data, the latter species is endemic to the Cape Province, and is mainly dark brown with narrow, longitudinal blackish stripes over its elytra.

A third, peculiar, small hydrophilid *Spercheus cerisyi* Guerin-Méneville (about 4 mm long and pale brownish grey in colour) appeared to be common on kelp during the winter and spring in estuaries around the Cape Peninsula. It was very often associated with the chrysomelid *Monolepta bioculata* (Fabricius) (of about the same size), which has four large, oval white spots surrounded by black margins on the dorsum of its orange body. Both beetles were found to feed on the fluids oozing from the decaying kelp. This hydrophilid (subfamily Spercheinae) is apparently a water-living species.

Cercyon maritimus Knisch

DESCRIPTION

Adult (Fig. 4A)

Previously described by Knisch (1924*a*). Small, rather variable beetles, varying in colour from brown to almost pitch black; in some cases elytra brownish,

marked with black. Each elytron with about nine shallow punctured striae and densely pitted all over, the pits small and as wide apart as their diameter. Beetles vary from 3,7 to 4,6 mm in length.

Widely distributed along the Cape coasts.

Larva (Fig. 4B)

Resembles larva of histerids, but easily distinguished by the last abdominal segment or stigmatic atrium (Fig. 4M), which consists of the tergal plate of the eighth segment, the median and lateral lobes of the ninth segment (lateral lobes also known as acrocerci), the true cerci or mesocerci, each with a long filament at apex, and the procerci, which are actually processes of the eighth pleurites. All spiracles including those of mesothorax of equal size and of biforous type; seven pairs laterally on abdomen, eighth pair opening in atrium. Pro-, meso- and metathoracic shields well developed, though small on last two thoracic segments. Full-grown larvae measuring 10–11 mm in length and dirty to creamy white in colour, except head, thoracic shields and eighth abdominal plates, which are reddish brown and somewhat shiny. Body integument leathery, tough and covered with microscopic spinules (Fig. 4N). Legs present, with femur and tibia distinguishable although minute (contradicts Richmond's (1920) statement that legs are entirely absent in *Cercyon*).

Head capsule (Fig. 4C–D)

Oval, somewhat upwardly directed in most specimens seen, with small ocellus on each side. Frontal sutures not visible. Antennae three-segmented, with first segment about twice as long as the second; latter with small, apparently two-segmented appendage; third segment smaller than the second and with some sensory pegs apically. Postgenae ventrally separated by gular suture, which is Y-shaped and delimits a pregular area anteriorly between its arms. Arrow-shaped tentorial pit posteriorly, almost in centre. Chaetotaxy as illustrated.

Mandibles (Fig. 4H, L)

About half as long as cranium and nearly one-third longer than wide. Broad basally, cutting edge of left mandible without teeth, that of right mandible with single short tooth (t_1) about half-way between apex and molar area. Teeth very similar to those of *C. quisquilius* (Linnaeus) (Hafez 1939*d*). Molar area thin and almost trenchant in both mandibles, forming a ridge rather than teeth; that of left mandible somewhat broader than that on right. Penicilli not present in the specimens examined. Ventral side of left mandible with longitudinal, curved median groove visible through dorsal integument for reception of right mandible.

Maxillae (Fig. 4I–J)

With broad cardo and stipes, nearly twice longer than wide and with more or less shiny, oval area dorsolaterally furnished with fine setae; mesal margin bearing eight to nine short setae. Fairly long seta also present apically on lateral

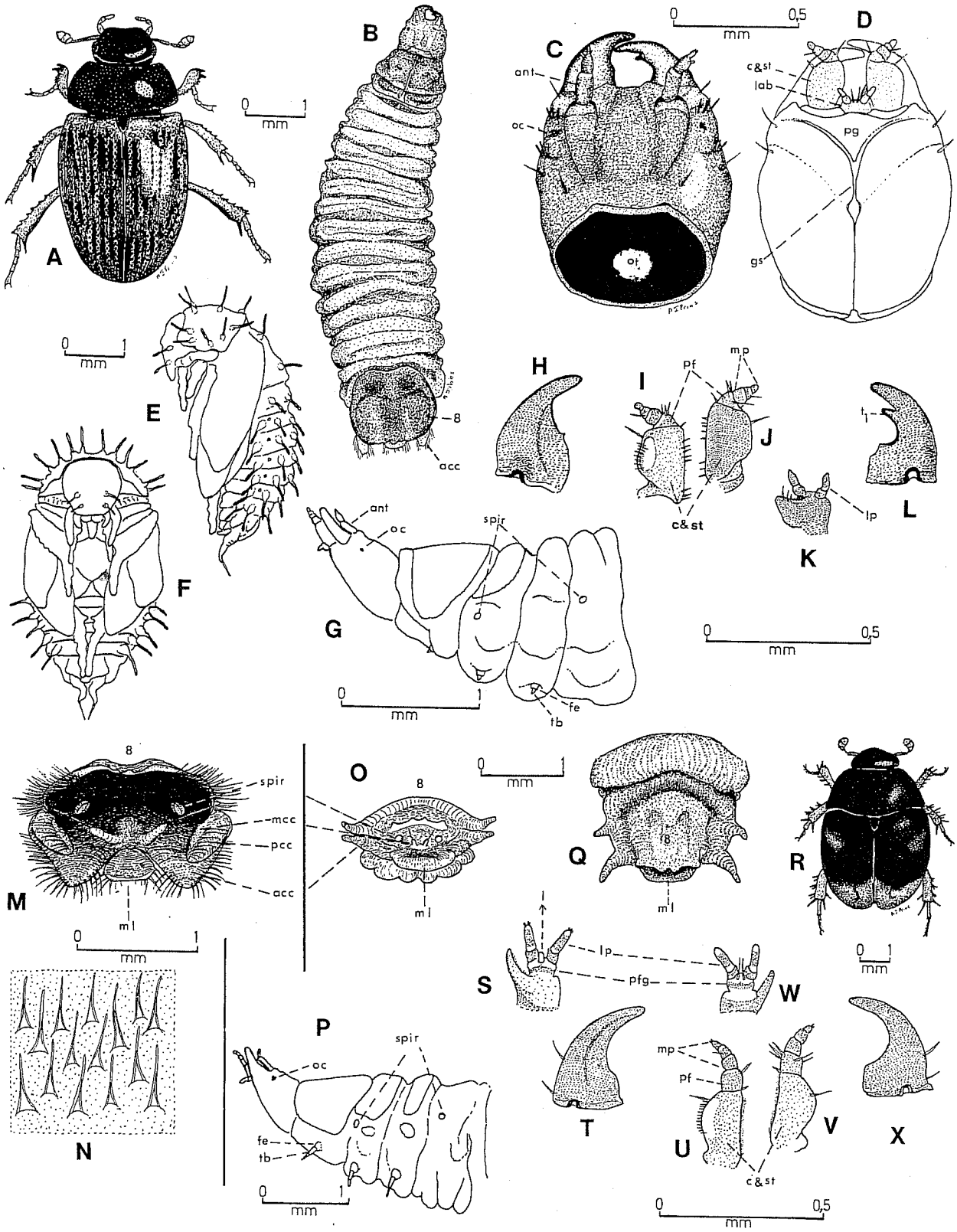

Fig. 4. Family Hydrophilidae.
A–N. *Cercyon maritimus*. A. Adult. B. Larva (dorsal view). C. Head (dorsal view). D. Head (ventral view). E. Pupa (left lateral view). F. Pupa (ventral view). G. First three segments of larva (left lateral view). H. Left mandible (dorsal view). I. Left maxilla (dorsal view). J. Left maxilla (ventral view). K. Labium (dorsal view). L. Right mandible (dorsal view). M. Atrium, straight from behind. N. Integument showing spinules (highly magnified). O–X. *Sphaeridium caffrum*. O. Atrium, straight from behind. P. First three segments of larva (left lateral view). Q. Atrium (dorsal view). R. Adult. S. Labium (dorsal view). T. Left mandible (dorsal view). U. Left maxilla (dorsal view). V. Left maxilla (ventral view). W. Labium (ventral view). X. Right mandible (dorsal view).

side. Ventrally without setae. Maxillary palp three-segmented, with segments tapering towards the apex and of about equal length, the second segment bearing long seta. Apical segment with sensory pegs at apex. Palpifer segment-like and bearing two long setae ventrally; also two to three shorter setae near apical border on mesal side, probably remnant of galea. Short spine-like seta also present basally on mesal margin.

Labium (Fig. 4K)

Small, represented by prementum and two-segmented palpi. Mentum dorsally asymmetrically developed in all specimens seen, forming long, almost triangular projection on left side, which bears some short setae on anterior part. When viewed from below a small part of this projection is visible on mesal side of left cardo-stipes.

Pupa (Fig. 4E–F)

Almost pure white after pupation, but soon changes to straw-yellow with blackish eyes. Head with four tubercles, each bearing long, thick seta or stylus; pronotum with about ten stylus-bearing tubercles on anterior and posterior margin as well as two near middle. Meso- and metathorax with stylus-bearing tubercle on each side of median line. Abdomen on each side with three rows of stylus-bearing tubercles, of which one row is situated laterally. Wings folded down over ventral side of body. Developing genital capsule present as two small, elongate cones situated close together. Fleshy cerci divergent in most specimens studied, each with long filament attached to larval skin. Five pairs of spiracles clearly visible, sixth pair small and inconspicuous. Body length of specimens examined 3,7–5,5 mm.

BIOLOGY

Adults and larvae were observed almost throughout the year, mostly in kelp, but sometimes also in fresh cow-dung. As already stated, the larvae are mainly predacious, but will feed on the colloids oozing from decaying kelp. Larvae collected in this medium along the west coast during spring had a life-span of at least 40 days before pupation occurred. Most pupae were found in the top few centimetres of soil in oval earthen cells constructed by the larvae. Pupal stages varied from 9 to 12 days during August and September, the newly emerged beetles being yellowish white with some orange coloration on pronotum. Those observed assumed their normal dark colour after a few days to about a week.

Sphaeridium caffrum Laporte & Castelnau

DESCRIPTION

Adult (Fig. 4R)

Length 4,3–5,5 mm. Oval, black, only slightly shiny, with fulvous or paler spot near base of each elytron as well as fulvous or paler area on apical third of

elytra. Latter without longitudinal striae but densely punctate, the punctures being small and shallow. External border of elytra also pale fulvous. Legs brownish, furnished with spines.

Widely distributed in South and east Africa and Madagascar (Knish 1924*b*). Specimens studied here were collected mostly in the western parts of the Cape Province.

Larva

Very similar to *Cercyon maritimus*, but easily distinguished by absence of extra tooth on right mandible and by stigmatic atrium, which bears two fleshy projections on each side (the procerci and acrocerci) (Fig. 4Q). Eighth pair of spiracles also opens into atrium. Mesocerci much shorter than in *C. maritimus* and also furnished apically with filament or seta; median lobe broader than in latter species (Fig. 4O), its hind margin almost quadridentate as in *Sphaeridium scarabaeoides* (Linnaeus) (Hafez 1939*b*). Seven pairs of biforous spiracles present laterally on abdomen. Legs much larger than in *C. maritimus* and, apart from femur and tibia (with circle of about nine short setae around apex), third or tarsal segment with one or two setae at tip also present (Fig. 4P). Integument leathery and covered with minute spinules similar to those of *C. maritimus*; also some short setae present. Full-grown larvae measure 8–9,5 mm and are of same colour as those of the latter species.

Head capsule

Very similar to that of *C. maritimus*, including structure of gular suture; also without frontal suture. With two to three ocelli on each side. Integument fairly shiny and brown and cranium wider behind than in front. The antennae three-segmented as in *C. maritimus*, but projection on second segment lacking; second segment also about half the length of first; third segment smallest and with short setae or sensory pegs at tip.

Mandibles (Fig. 4T, X)

Similar to those of *C. maritimus*, including the ventral groove on left mandible, but lacking tooth between apex and molar area on right mandible. Molar areas trenchant. Two small setae usually present on exterior sides, one situated near base.

Maxillae (Fig. 4U–V)

Very similar to those of *C. maritimus*, with cardo-stipes somewhat extended on exterior side and with long seta and also with about four shorter setae ventrally. Mesal margin with numerous very fine setae, otherwise exactly as in *C. maritimus*, including setae on palpifers. Second palpal segment with short seta on both mesal and lateral margin; apical segment with short spine-like seta near base on mesal side, and with sensory pegs at apex.

Labium (Fig. 4S, W)

Very similar to that of *C. maritimus*, but differs from it by longer labial palpi, longer and more pointed projection on left side, which is furnished with fine setae on anterior margin and by presence of a short ligula, which is about three-quarters the length of first segment of palpi. Palpiger about as long as first segment of palpus.

Pupa

Very similar to that of *C. maritimus*, including apical cerci and styli. Number of styli on body and particularly those on head and pronotum also similar to those of latter species, although much longer and thinner in all specimens examined. Cerci somewhat shorter than in *C. maritimus*. Most pupae about 5,4 mm long. Colour of pupae at first more or less creamy white, but eyes become brown after a few days. Whole pupa changes to darker colour just before beetle emerges.

BIOLOGY

Large numbers of beetles were collected in fresh and semi-fresh cow-pats in the western parts of the Cape during the summer and autumn and larvae were observed during the early part of the summer, producing pupae during December and January. The larvae pupate in small cells constructed in the drier parts of the dung and, to judge from their intestinal contents, most of the larvae collected in the pats must have been feeding mostly on the decaying material, particularly the liquids oozing from the wet particles. When crowding occurs they become cannibalistic.

Family **Histeridae**

Very small to medium-sized, oval hard-bodied beetles, head deeply sunk into prothorax, short legs and eleven-segmented antennae capable of being retracted. Tarsal formula 5–5–5 or 5–5–4. Wings well developed; elytra usually not covering last two abdominal segments.

Some 150 species of histerids have already been described from southern Africa, most of which are predacious on coleopterous and dipterous larvae and other smaller arthropods. According to Nuorteva (1970), who experimented with histerids in Finland, there is a very high negative correlation between the occurrence of blow-flies and histerids in fish carcasses. Bornemissza (1968) reported up to 50 per cent kill of fly maggots in cow-pats by *Pachylister chinensis* (Quensel) in Fiji. Some species, however, live in the burrows of small mammals or in the nests of birds (Arnett 1963), particularly species of *Saprinus, Gnathoncus*, and *Hister*; others again have developed a myrmecophilous or termitophilous life, such as species of *Monoplius* as well as *Hister*. Species of *Teretrius*, which are cylindrical in form, live in the burrows of wood-boring beetles, whereas the flat species of the genera *Hololepta, Pachycraerus*, and *Paromalus* are

Family **Silphidae**

Small to moderately large (about 40 mm) flattened beetles, usually sombre coloured, often with metallic blue sheen; some with red or orange markings. Apical abdominal segments often exposed. Antennae ten- to eleven-segmented. Tarsal formula 5–5–5. Most of them are carrion feeders, both in the adult and larval form; some feed on snails and lepidopterous larvae and a few are phytophagous (not present in South Africa). Species of the genus *Nicrophorus* (not occurring in southern Africa) have the habit of burying the carrion to ensure an adequate food-supply for the larvae; they are therefore known as burying beetles.

Only about ten species have been described from the Subsaharan region, of which the endemic *Silpha mutilata* Laporte & Castelnau and the more widespread *S. micans* Fabricius have been introduced into Europe. The latter, together with *S. caeruleoviridans* Dohrn (also widely distributed in the Cape Province, South West Africa and Zimbabwe), were described under the subgenus *Chalcosilpha*; however, according to Arrow (1909) these two species are conspecific. The largest species found in the Cape Province are *S. capicola* Péringuey, *S. peringueyi* Portevin, and *S. punctulata* Olivier (which is common in fynbos along the western parts of the southern Cape), all measuring 17 to 20 mm in length.

Both *S. micans* and *S. mutilata* (which differs from the first-mentioned species by the small elevated area or ridge in the middle of each elytron) (Fig. 2F) were found to be common on carcasses of mammals and birds both on the coast and inland, and were also attracted to soil containing decomposing fishmeal. However, only the one species, *S. micans*, was observed to breed in this medium and in the carcasses examined.

Silpha micans Fabricius

DESCRIPTION

Adult (Fig. 15A)

Elytra blackish to blackish brown with rest of body, including legs and antennae, blackish blue, in some cases even iridescent blue; legs perhaps more bluish brown; eyes black. Integument leathery, elytra not covering three to four terminal abdominal segments. Each elytron with three almost indistinct longitudinal rugae, of which the exterior one is the most prominent and reaches only to about the posterior one-third of the wing cover. Tibiae with numerous spines. Wings well developed. Antennae with three-segmented club. All tarsi five-segmented. Length 12,6–13,8 mm.

Widely spread in the Subsaharan region (Jeannel & Hatch 1928).

Larva (Fig. 15C)

General description of the larva of a *Silpha* sp. is given by Dorsey (1940). Depressed dorsoventrally and wider in front than behind. Thoracic terga rounded laterally. Abdominal terga, except ninth and tenth, with anterolateral angles

rounded, posterolateral angles acute, and lateral and posterior borders furnished with setae, some of which (particularly lateral ones) are more strongly developed. Head narrower in front than behind; nearly cordiform. Nine pairs of spiracles situated ventrally, with mesothoracic one largest; first abdominal pair somewhat larger than the other abdominal spiracles; all oval or annular; mesothoracic pair (Fig. 15P) furnished with two setae each, situated on internal side. Colour dark brown to blackish brown, particularly posterior third of each segment. Integument leathery and covered with small tubercles and medium-long setae (Fig. 15S) most of which are cleft at tip, or even cleft two or three times. Sculpture on thoracic terga present as wide, irregular reticulation, particularly on the anterior part of the pronotum. Ecdysial suture distinct in most segments, except perhaps last two or three. Tenth abdominal segment almost tubular, about as long as ninth and tapering towards apex; ninth fringed with fine setae.

Legs (Fig. 15H) well developed, slightly increasing in size from hind legs to forelegs; coxae large, with longitudinal groove on exterior face distinct; strong spine-like setae present, both ventrally and dorsally on tibiae, ventrally only on femora; dorsal setae on latter short but slender; tarsungulus acute and with one ventral and one posterior spine about half-way between base and apex. Urogomphi borne on ninth abdominal segment; fairly long, appearing two-segmented, with first segment much longer than terminal one and furnished with spine-like setae; latter segment subdivided into a smaller proximal and larger distal part in some specimens; with one or two pre-apical setae and with a medium-long seta apically. Mature larvae measure about 14 mm in length.

Head capsule (Fig. 15E–G)

Slightly less than twice as wide as long. Sides very convex, epistomal and frontal sutures clearly indicated. Distal ends of dorsal tentorial arms, although contiguous with frontal sutures, are not in line with antennal sockets as stated by Dorsey (1940) but further back, more or less in line with dorsal ocelli. Latter four in number and situated on lateral margin, about half-way between base and apex. Ventral ocelli two in number, with anterior one situated just below antennal socket. Frontoclypeal suture indicated only laterally, obsolete over middle portion. Posterior margin of head widely and shallowly emarginate dorsally. Antennae three-segmented, with first and apical segments of about equal length, second one somewhat longer and bearing projection on mesal part of its apex. Last two segments with setae. Chaetotaxy of head in most cases as illustrated. Sculpture consisting of small tubercles arranged in form of a wide reticulation, areas between striae minutely reticulate and shiny. Frons more rugulose, with reduced number of tubercles. Head divided ventrally into two halves by deep, emarginate hind border; gula short.

Labrum and clypeus

Labrum and clypeus united, almost triangular; boundary between them indicated by more weakly sclerotized cuticle. Labrum more or less smooth, with

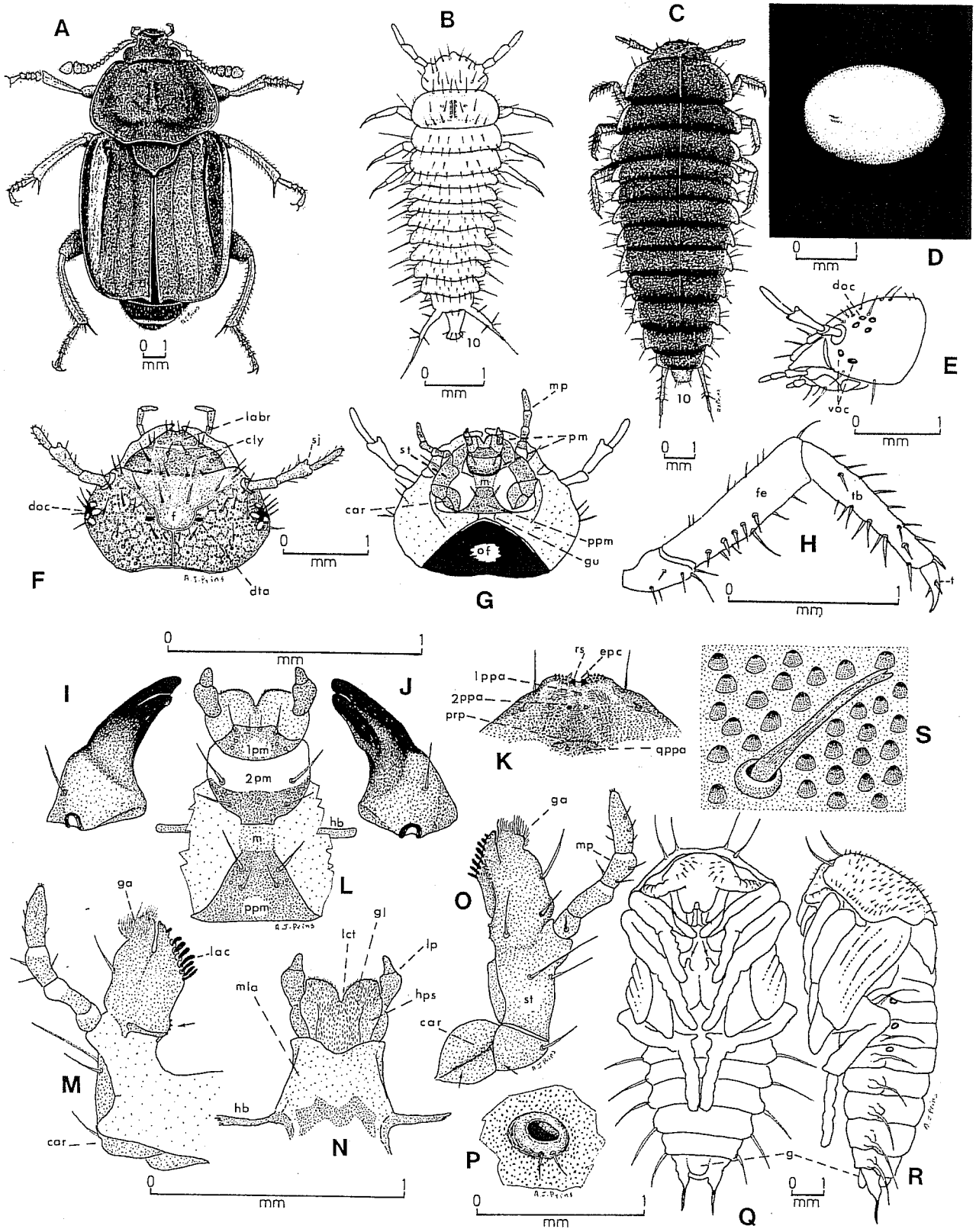

Fig. 15. Family Silphidae.

Silpha micans. A. Adult. B. Newly hatched larva (dorsal view). C. Adult larva (dorsal view). D. Egg. E. Head (left lateral view). F. Head (dorsal view). G. Head (ventral view). H. Right mesothoracic leg. I. Left mandible (dorsal view). J. Right mandible (dorsal view). K. Epipharynx. L. Labium (ventral view). M. Left maxilla (dorsal view). N. Labium (dorsal view). O. Left maxilla (ventral view). P. Left mesothoracic spiracle. Q. Pupa (ventral view). R. Pupa (left lateral view). S. Dorsal integument showing tubercles and hair (highly magnified).

few superficial rugae and minute reticulation between rugae; anteriorly bilobed due to presence of short medial cleft; lateral margins sinuate just behind cleft. Labrum with four strong setae on each side of which posterior one is situated on small, lateral, triangular sclerotized area in front of clypeal border; tiny seta also present on each side of labral cleft. Clypeus more or less rugoso-reticulate, about as long as, or slightly longer than, labrum; trapezoidal and bearing transverse row of about six setae behind anterior margin.

Epipharynx (Fig. 15K). Bilobed in front, anterior and lateral margins sclerotized, each lobe in front with rounded denticles, as well as triangular tooth (Dorsey's (1940) rectangular tooth), lateral margins each with short spine situated in line with second porous area. Median area concave, forming more or less a lobe on each side, bearing an oval area beset with spiculi; the two quinqueporous areas clearly indicated in most specimens with anterior parabolic row of fine pores. First porous area visible as two small circles just behind triangular teeth. Anterior to each spiculum-bearing area and just behind anterior lobes in line with first porous area is a small transverse area with fine setae.

Mandibles (Fig. 15I–J)

Slightly shorter than cranium, fairly narrow, with broad subtriangular base and nearly twice as long as width at base. Each mandible with an oblique, transverse dorsal depression separating cutting edge from base. Molar areas absent, cutting edge on each side comprised of two rounded teeth of which apical one is largest. Dorsal carinae absent; mandibles rounded on lateral face, each with single seta.

Maxillae (Fig. 15M, O)

Elongate, mala and stipes fused, lacinia and galea free only at extreme apex; latter with tuft of very fine hairs. Lacinia with eight to nine broad palus-like spines giving it a comb-like oblique anterior margin; mesal area of lacinia with some minute denticles at base. Maxilla dorsally without setae, ventrally with about five, of which one is situated half-way between galea and palpifer and one just below palpifer. Cardo somewhat oval, with Y-shaped suture (arms of Y pointing posteriorly) and with only one seta laterally on apex. Maxillary palpus appearing four-segmented, with apical segment the longest; third segment shorter than the second; first segment very small and with single seta ventrally; both apical and penultimate segments with setae. In his study of six American species, Dorsey (1940) gives the number of palpal segments as three.

Labium (Fig. 15L, N)

Different sclerites fairly easily recognizable; postmentum large and triangular or trapezoidal, usually bearing four setae near anterior margin. Mentum small and less sclerotized. Prementum large, consisting of basal sclerite, ventrally with four setae of which two are situated on its anterior, less sclerotized half. Apical sclerite with two-segmented palpi; this sclerite ventrally also with four setae.

Hypopharynx (Fig. 15N). Glossa deeply cleft in the middle, the two lobes densely covered with fine hairs; hypopharyngeal sclerome (= paraglossae, Böving & Craighead 1931) distinct; hypopharyngeal bracon well developed and symmetrical. Superlinguae united as one broad structure.

Pupa (Fig. 15Q–R)

Exarate, clearly showing broad pronotum of the adult. Anterior margin of pronotum with four long setae and some smaller hairs on disc; small hairs also present on posterior part of head. Abdominal segments each with long lateral setae; apex of abdomen with two strong setae or styli. Developing genital capsule visible as broad lobe between caudal styli. Anterior border of metathorax ventrally with two fleshy spines. Only first four pairs of abdominal spiracles large and clearly visible. Length 11–12 mm.

Newly formed pupae are almost pure white with golden brown hairs; as they develop they become darker, and just before emergence of beetles they are piceous.

BIOLOGY

Beetles were collected during midsummer and midwinter and usually appear wherever carcasses and skins are found. They feed on the latter or on other arthropods present, particularly on fly and blow-fly larvae. They are attracted to fish-meal in large numbers and eggs were often found during January and February in soil containing this medium.

Most of the eggs (Fig. 15D) collected in Claremont, Cape Town, vary from 2,20 by 1,4 mm to 2,4 by 1,6 mm and are oval, yellowish white and almost smooth and shiny. Most eggs were laid singly in the upper few millimetres of soil that contained fish-meal and hatched after 2–3 days during January. Shortly before hatching, two narrow dark lines separated by a thin pale line are visible near the anterior pole of the egg.

Newly hatched larvae (Fig. 15B) are similar to the mature larvae except in colour and size, and are almost pure white with reddish eyes, golden-coloured setae, and two dark or piceous parallel lines on the pronotum (already visible through the chorion in the embryo). These two black lines are visible only in the newly hatched specimens; after the first moult the lines disappear. The newly hatched larvae measure 4–4,2 mm in length and within 2–3 hours they turn to almost pitch black, with reddish eyes. In the laboratory the first instar lasted for about a day. After each moult the larvae are nearly white; second and third instar larvae usually assume their black colour after 2–4 hours, as in the first instar.

The second moult occurs 2–5 days after the first and the larvae then measure 9–10 mm. Within 3–4 days after the second moult they are 13–14 mm long and usually enter the soil, where they construct thin-walled clay cells in which they remain dormant for another 3–4 days before pupation occurs. The total lifespan of the third instar larvae varies from 6 to almost 8 days and the pupal

stages also last for 6–7 days, the adult beetles emerging 17–24 days after oviposition.

Newly emerged beetles are almost white with yellowish-brown pro- and mesonotum; the head is darker and the eyes dark brown; the last abdominal segment, legs, and antennae are pale yellowish brown. After a day or so they assume their normal dark coloration.

Silpha punctulata Olivier

DESCRIPTION

Adult

Dull, brownish black, about 19 mm long, somewhat more oval in outline than *S. micans*, the elytra covering the abdomen. Head and prothorax fairly densely punctate, the punctures coarser on the lateral areas of pronotum than on its disc. The six elytral rugae very prominent, areas between them punctate, the punctures coarser than on pronotum. Legs microscopically reticulate-punctate or rugulose, tibiae spined as in *S. micans*. Antennal club not very prominent, the three segments clearly demarcated by presence of fine, short hairs causing pruinescence, rest of antennae slightly shiny as in the other species. It differs from *S. micans* by absence of hairs on dorsal surface of pronotum and elytra.

This species is widespread in the Subsaharan region (Jeannel & Hatch 1928); collection records also come from the western Cape Province.

Larva (Fig. 16A)

When mature about 25 mm long and brownish black in colour. Very similar to that of *S. micans*, but somewhat more elongate; abdominal terga lobe-like on each side, these lobes acuminate or pointed posteriorly. Meso- and metathoracic segments with posterior angles less acute than those of abdomen; prothoracic angles rounded; all posterior angles of body segments each with a short spine-like seta; anterior angles, except those of pronotum, each with three to four short setae. Ecdysial suture fairly distinct in most segments except probably last three or four. Urogomphi shorter in relation to body length than in *S. micans*, appearing two-segmented, with second segment also subdivided in most specimens examined and the setation similar to that of the latter species.

Legs similar to those of *S. micans* with somewhat more spine-like setae present on both femur and tibia. Body integument (Fig. 16C) dorsally covered with short scale-like setae forming a single row along posterior border of segments, except that of abdominal segment nine, which is without such a row. Setae on posterior border of tenth segment longer and spine-like. The integument differs from that of *S. micans* by the distinct reticulation and by the smaller and less obvious tubercles that are present; apices of scale-like setae entire, not cleft. Spiracles similar to those of the latter species, but lacking the two setae on internal side of the mesothoracic pair.

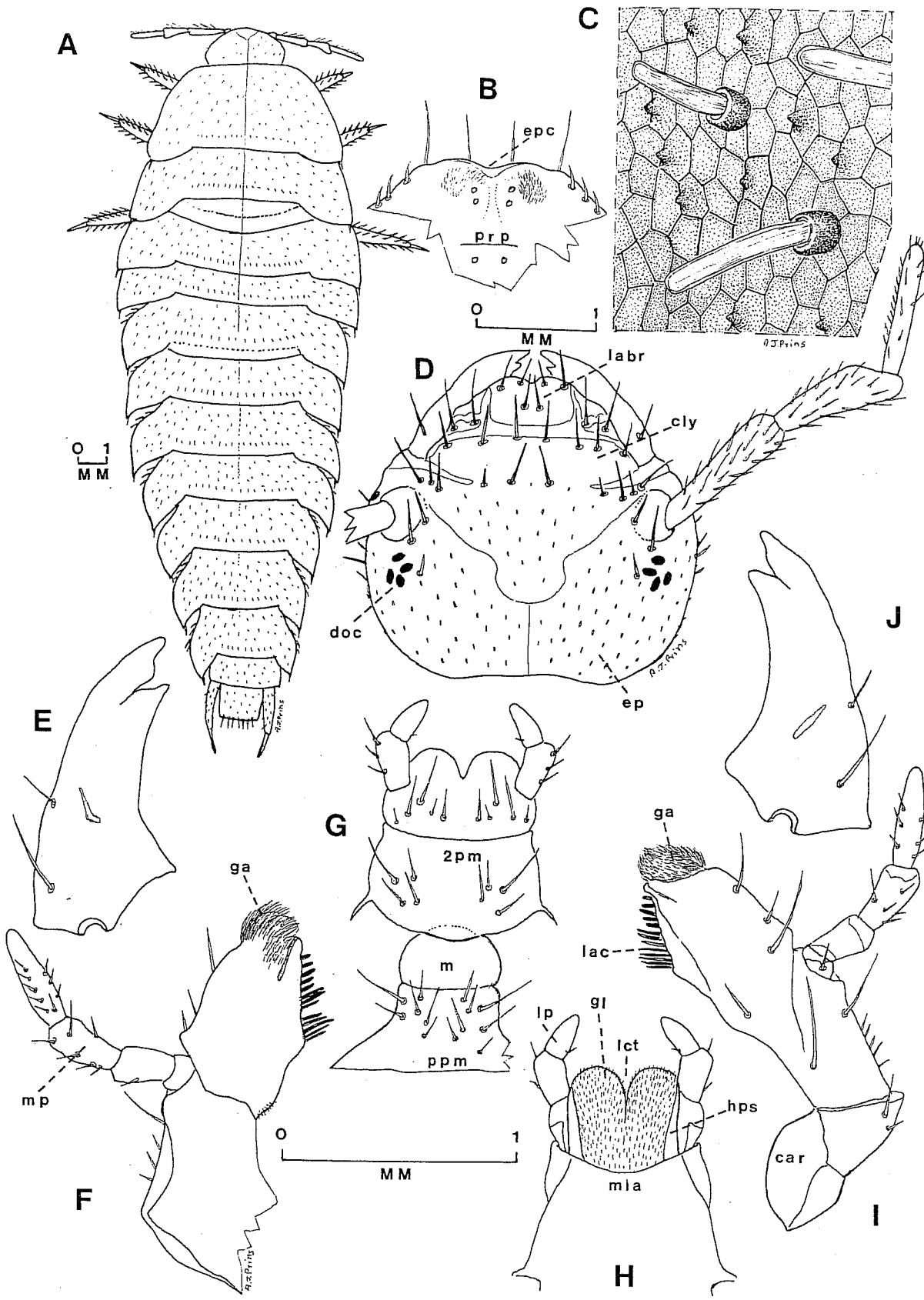

Fig. 16. Family Silphidae.
Silpha punctulata. A. Adult larva (dorsal view). B. Epipharynx. C. Dorsal integument showing tubercles and hair (highly magnified). D. Head (dorsal view). E. Left mandible (dorsal view). F. Left maxilla (dorsal view). G. Labium (ventral view). H. Labium (dorsal view). I. Left maxilla (ventral view). J. Right mandible (dorsal view).

In small larvae measuring about 10,5 mm long that were collected during January, all the antennal segments are about of equal length. In most of the specimens examined there are only about six long setae on the sternal plate just behind the head (about twenty-four in the mature specimens) and there is an extra-long seta on each lateral margin of the central disc of the labrum. There are also only two long setae ventrally on apical segment of labium, the other setae present are short and almost spine-like. Otherwise exactly as in the mature larva.

Head capsule (Fig. 16D)

Dark brown to blackish brown, about as long as wide or only slightly wider than long; minutely, or rather microscopically, reticulate-punctate and somewhat shagreened: cranial chaetotaxy as illustrated, similar to that of *S. micans* but differing from it by presence of short scale-like setae and absence of long setae on dorsal surface of epicranium, except two long setae in front of the four dorsal ocelli just behind antennal base, and one short spine-like seta dorsolaterad of median ocellus. Antenna three-segmented, first segment slightly longer than third (of about equal length in *S. micans*); second segment about as long as apical one (as in the case of the latter species) and without a conical projection. All segments with setae (in *S. micans* the first segment is without hairs).

Ventral side of head similar to that of *S. micans*, including two ventral ocelli, but postmentum with more setae.

Labrum and clypeus (Fig. 16D)

Labrum and clypeus united as in *S. micans* and similar in shape; labrum fairly deeply emarginate on anterior border, lateral margins sinuate behind cleft; dorsal surface with ten long setae, of which two are situated on each side on the sclerotized triangle, just in front of clypeal border. There is no demarcation line between clypeus and frons, except the sulcus on each side as in other species.

Epipharynx (Fig. 16B). Rather similar to that of *S. micans*; however, triangular teeth at apex are absent. Oval area with fine hairs present just behind anterior margin on each side of median concavity. Lateral margins with three short almost sickle-shaped setae (absent in *S. micans*) and denticles present on anterior margin of the latter species absent in this case.

Mandibles (Fig. 16E, J)

Slightly shorter than cranium, fairly narrow and more elongate than in *S. micans* due to narrow bases. As in latter species, a fairly prominent oblique depression present on each mandible separating cutting edge from base. Lateral faces fairly rounded, each mandible with two setae of which proximal one is longest. Two teeth of cutting edge distinct, apical one usually bilobed and larger than the other.

Maxillae (Fig. 16F, I)

Similar to those of *S. micans*, but in this species the lacinia and galea entirely fused, the demarcation line still visible, particularly on dorsal side. Galea forming a lobe with fine golden setae as in latter species; lacinia with twelve to thirteen palus-like spines, of which distal five are shorter with rounded apices, the other eight or nine longer. Mesal area of lacinia also with minute spines at base. Maxilla dorsally without setae, ventrally with about six setae as indicated in Figure 16I; exterior margin below palp with five short setae. Cardo as in *S. micans*, but with one long and one short seta near apex.

Maxillary palpi four-segmented as in *S. micans*, first segment small with one ventral seta, third segment longer than second (shorter than second in *S. micans*), apical one the longest. Both apical and penultimate segments with setae, second with only a single dorsolateral seta.

Labium (Fig. 16G–H)

Also similar to that of *S. micans*, postmentum triangular with about fourteen setae. Mentum smaller, less sclerotized and without setae. Prementum large and with about four setae ventrally on each side of its median area. Apical sclerite ventrally with about ten setae and with two-segmented palpi of which basal segment is slightly longer than apical one and bearing about four setae on exterior margin; apical segment with only a single short seta on its mesal margin in most specimens examined. Glossa deeply cleft in middle, the two lobes densely covered dorsally with fine hairs; hypopharyngeal sclerites clearly demarcated.

BIOLOGY

Nothing is known about the life history of these beetles. Larvae were observed wandering about on the ground covered with fynbos.

ACKNOWLEDGEMENTS

I am grateful to Dr S. S. Walters (Dept. of Agriculture, Elsenburg) and Dr V. B. Whitehead (South African Museum) for reading the manuscript and for helpful suggestions, and to Mr V. Branco (South African Museum) for preparing some of the illustrations.

REFERENCES

ARNETT, R. H. 1963. *The beetles of the United States*. Washington: Catholic University of America Press.

ARROW, G. J. 1909. Systematic notes on Coleoptera of the clavicorn families. *Ann. Mag. nat. Hist.* (8) **4**: 190–196.

BACKLUND, H. O. 1945. Wrack fauna of Sweden and Finland. Ecology and chorology. *Opusc. ent.* **5**: 1–236.

BERNHAUER, M. & SCHUBERT, K. 1914. Staphylinidae IV. *Coleoptm Cat.* **57**: 289–408.

BORNEMISSZA, G. F. 1968. Studies on the histerid beetle *Pachylister chinensis* in Fiji, and its possible value in control of buffalo-fly in Australia. *Aust. J. Zool.* **16**: 673–688.

BÖVING, A. G. & CRAIGHEAD, F. C. 1931. An illustrated synopsis of the principal larval forms of the order Coleoptera. *Entomologica am.* **11**: 1–351.

BÖVING, A. G. & HENRIKSEN, K. L. 1938. The developmental stages of the Danish Hydrophilidae. *Vidensk. Meddr. dansk naturh. Foren.* **102**: 27–162.

DORSEY, C. K. 1940. A comparative study of the larvae of six subspecies of *Silpha* (Coleoptera: Silphidae). *Ann. ent. Soc. Am.* **33**: 120–139.

EMDEN, F. I. VAN. 1942. A key to the genera of larval Carabidae (Col.). *Trans. R. ent. Soc. Lond.* **92**: 1–99.

HAFEZ, M. 1939*a*. The life history of *Philonthus quisquiliarius* Gyllh. *Bull. Soc. ent. Egypt* **23**: 302–311.

HAFEZ, M. 1939*b*. The life history of *Sphaeridium scarabaeoides* L. *Bull. Soc. ent. Egypt* **23**: 312–318.

HAFEZ, M. 1939*c*. The external morphology of the full-grown larva of *Oxytelus latiusculus* Kr. *Bull Soc. ent. Egypt* **23**: 333–338.

HAFEZ, M. 1939*d*. The external morphology of the full-grown larva of *Cercyon quisquilius* L. *Bull. Soc. ent. Egypt* **23**: 339–343.

HINTON, H. E. 1945. *A monograph of the beetles associated with stored products* **1**. London: The Trustees, British Museum (Nat. Hist.); Norwich: Jarrold & Sons.

JEANNEL, R. & HATCH, M. H. 1928. Silphidae. *Coleoptm Cat.* **95**: 63–244.

KASULE, F. K. 1968. The larval characters of some subfamilies of British Staphylinidae (Coleoptera) with keys to known genera. *Trans. R. ent. Soc. Lond.* **120**: 115–138.

KAUFMANN, R. R. U. 1937. Investigations on beetles associated with carrion in pannal ash near Harrogate III. *Entomologist's mon Mag.* **73**: 268–272.

KNISCH, A. 1924*a*. Neue Afrikanische Palpicornier. *Wien. ent. Ztg* **41**: 17–24.

KNISCH, A. 1924*b*. Hydrophilidae. *Coleoptm Cat.* **79**: 1–306.

MORLEY, C. 1907. Ten years' work among vertebrate carrion. *Entomologist's mon. Mag.* **43**: 45–51.

NUORTEVA, P. 1970. Histerid beetles as predators of blowflies (Diptera, Calliphoridae) in Finland. *Annls zool. fenn.* **7**: 195–198.

PÉRINGUEY, L. 1896. Descriptive catalogue of the Coleoptera of South Africa. *Trans. S. Afr. phil. Soc.* **7**: 99–623.

PESCOTT, R. T. M. & MILLER, L. W. 1937. Codlingmoth and William pears. Control methods investigated. *J. Dep. Agric. Vict.* **36**: 479.

RICHMOND, E. A. 1920. Article 1. Studies on the biology of the aquatic Hydrophilidae. *Bull. Am. Mus. nat. Hist.* **42**: 1–94.

SCHEERPELTZ, O. 1973. Coleoptera: Staphylinidae. *S. Afr. anim. Life* **15**: 43–394.

THÉROND, J. 1956. Histeridae. *S. Afr. anim. Life* **3**: 295–303.

ABBREVIATIONS

acc	acrocerci
adn	adnasale
ant	antenna
bt	teeth on base of labium
car	cardo
carc	carina (see also ck)
ce	cercus (see also ur)
ck	cervical keel (see also carc)
cly	clypeus
col	collum
c & st	cardo and stipes
doc	dorsal ocelli
dta	dorsal spot of distal tentorial arms
ep	epicranium
epc	epipharyngeal cleft

f	frons
fa	finger-shaped air-tube of biforous spiracle
fe	femur
g	developing genital capsule
ga	galea
gl	glossa
gs	gular suture
gu	gula
hb	hypopharyngeal bracon
hps	hypopharyngeal sclerome
hy	hypostomal margin
il	inner lobe
jx	juxta
l	ligula
lab	labium
labr	labrum
lac	lacinia
lct	ligular cleft
lm	prostheca
lp	labial palp
ls	labial stipes
m	mentum
m_1, m_2	molar area
ma	mala
mcc	mesocercus
mel	mesothoracic leg
ml	median lobe
mla	superlinguae/maxillulae
mp	maxillary palp
mx	maxilla
mxs	maxillary articulating area
n	neck
na	nasale
oc	ocellus
of	occipital foramen
ol	outer lobe
par	parietalia
pcc	procercus
pen	penicillus
pf	palpifer
pfg	palpiger
pg	pregula
pm (1 pm, 2 pm)	prementum
1 ppa	first porous area
2 ppa	second porous area
ppm	postmentum
pre	preartis
prp	parabolic row of pores
prvt	praeventrite
pvt	postventrite
qppa	quinque porous area
ret	retinaculum
rs	triangular tooth
sj	sensory appendix
sm	submentum
spir	spiracle
st	maxillary stipes
t	tarsungulus

t_1–t_3	scissorial teeth
ta	tarsus and claw
tb	tibia
tpp	tentorial pit
tr	trochanter
ur	urogomphus (see also ce)
voc	ventral ocellus
vt	ventrite