CYCLOCEPHALA SIGNATICOLLIS BURMEISTER, AN INTRODUCED PASTURE SCARAB (COLEOPTERA).

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(Five Text-figures.)

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Synopsis.

The Argentinian scarab *Cyclocephala signaticollis* Burm. has become established in a number of Sydney suburbs. The first specimens were obtained in 1947.

This paper describes both the adult and larval stages, particular emphasis being placed on characters which enable them to be distinguished from those of native species of Dynastinae. The distribution of the species in South America and its life cycle under Australian conditions are briefly described.

The introduction is a cause for some concern, as the species is closely related to a number of turf and pasture pests in the Americas. Although only minor damage has been caused by the local Sydney population, the species may spread into areas more favourable to its survival and multiplication.

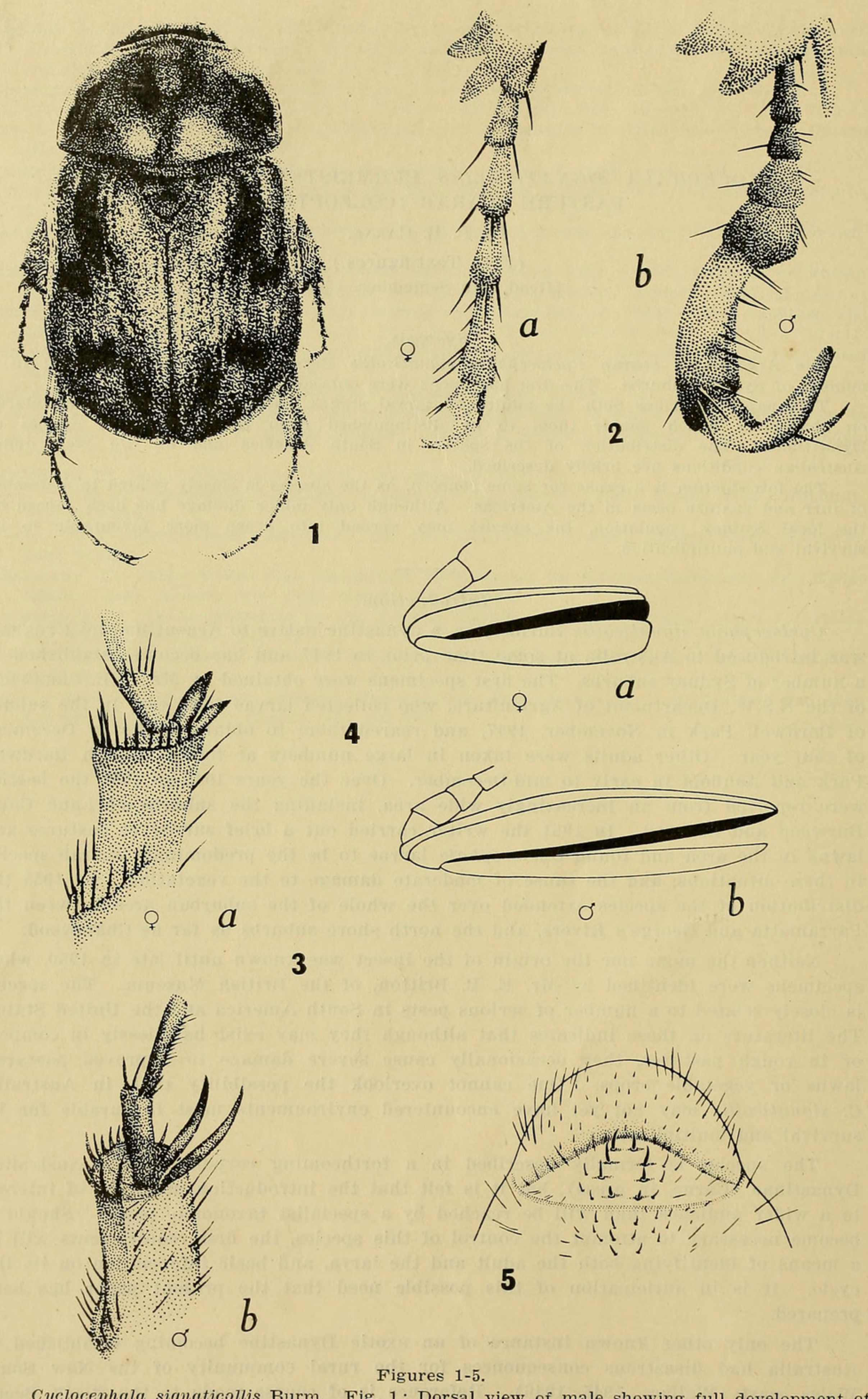
Introduction.

Cyclocephala signaticollis Burmeister, a dynastine native to Argentina and Uruguay, was introduced to Australia at some time prior to 1947 and has become established in a number of Sydney suburbs. The first specimens were obtained by Mr. C. E. Chadwick, of the N.S.W. Department of Agriculture, who collected larvae from turf in the suburb of Bardwell Park in November, 1947, and reared them to obtain adults in December of that year. Other adults were taken in large numbers at lights at both Bardwell Park and Ashfield in early to mid-December. Over the years 1948 to 1951 the beetles were reported from an increasingly wide area, including the suburbs of Lane Cove, Burwood and Concord. In 1951 the writer carried out a brief survey of pastures and lawns in the area and found *Cyclocephala* larvae to be the predominant scarab species in these situations, and the cause of moderate damage to the vegetation. By 1955 the distribution of the species extended over the whole of the suburban area between the Parramatta and George's Rivers, and the north shore suburbs as far as Chatswood.

Neither the name nor the origin of the insect was known until late in 1950, when specimens were identified by Mr. E. B. Britton, of the British Museum. The species is closely related to a number of serious pests in South America and the United States. The literature on these indicates that although they may exist harmlessly in compost or in rough pastures, they occasionally cause severe damage to improved pastures, lawns or vegetable crops. One cannot overlook the possibility that, in Australia, *C. signaticollis* may not yet have encountered environments most favourable for its survival and multiplication.

The species is formally described in a forthcoming revision of the Australian Dynastinae (Carne, in press), but it is felt that the introduction might be of interest to a wider audience than will be reached by a specialist taxonomic paper. Should it become necessary to attempt the control of this species, the first requirements will be a means of identifying both the adult and the larva, and basic information on its life cycle. It is in anticipation of this possible need that the present paper has been prepared.

The only other known instance of an exotic Dynastine becoming established in Australia had disastrous consequences for the rural community of the New South Wales coast (Wallace, 1945, 1946). Reference is of course made to the Black Beetle (*Heteronychus sanctae-helenae* Blanchard) which was introduced from South Africa



Figures 1-5.

Cyclocephala signaticollis Burm. Fig. 1: Dorsal view of male showing full development of colour pattern. Fig. 2: Anterior tarsus (*a*) of female, (*b*) of male. Fig. 3: Spurs of posterior tibia (*a*) of female, (*b*) of male. Fig. 4: Antennal club (*a*) of female, (*b*) of male. Fig. 5: Raster of third instar larva.

possibly during the period of the first World War. Neither the first appearance of this insect nor its subsequent spread was recorded, nor can it now be traced, as for ten years or more its identity was confused with that of a widely distributed native dynastine, *Metanastes vulgivagus* (Olliff). Early experiments on the control of the pest were almost certainly carried out with mixed populations of the two species, which differ considerably in their fundamental ecology.

Description of the Species.

(*a*) *Adult.*

The adult beetle (Fig. 1) is rather delicate, dorsally glabrous, and ranges in length from 1·34 to 1·50 cm. It is light brown to brownish-beige in colour, the pronotum somewhat darker than the elytra, but both with a surface gloss. The elytra and pronotum bear complex, bilaterally symmetrical, dark brown markings and shallow irregular punctation. In some specimens the elytral markings are obsolete, but a trace of the pattern always remains on the pronotum. The head is dark brownish-black, the clypeus a dull reddish-brown; the abdomen, legs and coxae are light brown, the latter with erect golden hairs. The pygidium is lightly and irregularly punctate, glabrous except for a central tuft of yellowish hairs on its posterior margin. The anterior claws of the female (Fig. 2, *a*) are equal and simple, and the tarsal segments equal in length. In the male (Fig. 2, *b*) the claws are much larger, strongly asymmetrical, the larger claw being finely toothed at its apex; the last tarsal segment is greatly enlarged to support the claws, and the preceding segments are correspondingly shorter and broader. Sexual dimorphism is also shown in the form of the hind tibial spurs (Fig. 3, *a* and *b*) and the antennal club (Fig. 4, *a* and *b*).

The insect is at once distinguishable from all endemic Dynastinae, none of which have dorsal colour patterns of the type here described and figured. The only endemic scarabaeids with which *C. signaticollis* could conceivably be confused are certain species of *Anoplognathus* (especially *abnormis* Macl.), but these are restricted in distribution to northern Queensland.

(*b*) *Larva.*

The larva is a typical "curlgrub". Whereas most native dynastine larvae have heavily punctured reddish-brown heads, and antennae with the ultimate segments each bearing four or more conspicuous sensory areas, the larva of *C. signaticollis* has a smooth yellow head, and the ultimate antennal segment bears a single dorsal and two ventral sensory areas. In this respect it is similar to certain ruteline larvae but, whereas the latter have finely and evenly ridged stridulating areas on the lower surfaces of their mandibles, those of the present species are coarsely and unevenly ridged, as in all other dynastines.

The third instar larva has a head capsule ranging in width from 4·4 to 5·2 mm. The following characters will enable it to be positively identified:

The head capsule is yellowish-brown and slightly rugulose; a weakly pigmented ocellus is present at the base of each antenna. All tarsal claws are long and slender. The two posterior pairs of abdominal spiracles are larger than the first six pairs, being approximately equal in size to those of prothorax.

The raster and lower anal lip bear numerous small hamate setae; in addition, on the lower anal lip there are some seven to nine exceptionally large and deeply pigmented hamate setae, with their sockets arranged in a roughly circular or oval pattern (Fig. 5).

The second instar larva is similar, but has a head capsule width of *c.* 2·9 mm. The first instar larva has a raster completely devoid of hamate setae; its lower anal lip and raster are uniformly covered with fine slender setae. The head capsule width is *c.* 2·1 mm.

The central group of large hamate setae on the lower anal lip of second and third instar larvae enables them to be distinguished immediately from all other scarabaeid larvae known to the writer. Certain melolonthine larvae have rather similar hair patterns, but in this subfamily the anal slit is longitudinal, not transverse.

The Ecology and Distribution of Cyclocephala spp. in the Americas.

Although nothing has been published concerning *C. signaticollis* other than its formal description (Burmeister, 1847), several other species have been studied intensively. Johnson (1941) gives an interesting account of the behaviour of *C.* (*Ochrosidia*). *borealis* Arrow in Connecticut, and confirms similar observations by Neiswander (1938) on the same species in Ohio. Adult flights of this species occur in late June and in July (corresponding to late December and January in Australia), and larval damage to turf is noticeable in both spring and autumn. Ritcher (1944) refers to *C. abrupta* Casey and *immaculata* Oliv. in Oregon and Kentucky respectively, and it is clear from his remarks that the life cycles of these two species are closely similar to that of *borealis*.

In a letter dated 19th June, 1951, the Director of the Instituto de Sanidad Vegetal, Buenos Aires, quotes Senor Antonio Martinez, a field entomologist, as follows: "*Cyclocephala signaticollis* Burm. is found in the provinces of Buenos Aires, the eastern part of Córdoba, southern Santa Fé, in Entre Rios and the north-east. of the Pampa territory. It is also known from the neighbouring country of Uruguay . . . . The roots of native grasses are the natural food of the larvae, while they also attack lucerne, wheat, maize, linseed, sunflower and barley. This information is based on unpublished personal observations" (author's translation).

This information indicates that the species occurs over an approximately circular area, of radius 2½ degrees of latitude, having Buenos Aires as its centre. As might be expected from their comparable situations and latitudes, the temperature régime of Buenos Aires (34° 36′ S.) is very similar to that of Sydney (33° 52′ S.), while both have a fairly evenly distributed average annual rainfall, although that of Sydney (48 in.) is appreciably greater than that of Buenos Aires (37 in.).

In its native country the species appears to be restricted to an area on the extensive coastal plain (0–600 ft. above sea level), having an average annual rainfall of from 30 to 50 inches. To the north and north-east the rainfall increases steeply to more than 80 inches; to the south and south-west there is a rapid decline to less than 10 inches. A narrow belt of 30–40 inch rainfall country extends across the continent in a north-westerly direction: the north-westerly limit of the species approximates to a point within this belt where rain ceases to be evenly distributed and falls mainly in the summer months. The probabilities are, therefore, that in Australia the species is unlikely to extend its range inland from the coastal plain or into areas outside the 30–50 inch average annual rainfall zone.

Observations on the Species in Australia.

Field observations in the Sydney area in 1951 showed that larval feeding and damage to vegetation was confined to the autumn and early winter months, there being no resumption of activity in the spring. Larval development is very rapid and most of the larvae have completed feeding by the end of May.

In Table 1 are summarized the percentages of the population in each growth stage at different times of the year.

Table 1.

The Development of C. signaticollis *in Relation to the Time of Year, Sydney, 1951.*

Percentage of Population in Each Stage.

Time of Sampling.	First Instar Larvae.	Second Instar Larvae.	Third Instar Larvae.	Prepupae.	Pupae.	Adults, Immature in Soil.	Adults, on Wing and Mature in Soil.
Mid-March	10	10	80	—	—	—	—
Late May	—	—	30	70	—	—	—
Early November ..	—	—	—	20	80	—	—
Early December ..	—	—	—	—	—	100	—
Late December ..	—	—	—	—	—	—	100

The adult is very short-lived and does not appear to feed. Examination of the mouth parts showed them to be poorly developed and probably non-functional; the mandibles are anteriorly excurvate, as are those of *C. borealis* Arrow (Johnson, 1941).

The flight period is from late November to early January, peak flights occurring in all years in late December. The adults first appear in flight at dusk, becoming strongly attracted to lights after dark; males outnumber females. Copulation occurs on the ground and the females burrow into the soil immediately after.

The species was found in greatest numbers in deep friable loams carrying couch grass (*Cynodon dactylon*) and *Paspalum dilatatum*. These grasses, together with a variety of weeds, form the main cover of uncultivated garden beds and disused allotments in the Sydney area. The species was also abundant in grazed *Paspalum*-subterranean clover pastures. In all situations its presence was indicated by an impoverishment of the *Paspalum*. The larvae seem to have high soil moisture requirements, for although their distribution was fairly uniform in March, 1951, by the end of May the greatest numbers were found in shaded or otherwise naturally damp situations.

C. signaticollis is able to complete its life cycle on a diet consisting solely of decomposing organic matter. Dense populations were found in old compost heaps, and larvae were successfully reared in the insectary in such material. On the other hand, the larvae were quite abundant (up to 15 per sq. link in May, 1951) in pastures, and here they probably derived at least part of their nutriment from the roots of grasses.

Discussion.

It seems very probable that the species was introduced by a ship having previously berthed at or near Buenos Aires. As the adult stage is short-lived and delicate, it is most likely that the insect was transported as larvae in soil, the adults emerging on arrival.

It is of particular interest to record that prior to 1947 not a single specimen of this beetle was taken in Sydney, despite the presence there of a number of amateur and professional entomologists who collect regularly in the vicinity of their homes. When the species was first observed it was extremely abundant over quite a large area. The maximum reproductive capacity of dynastid beetles is the order of 15–30×, and even had mortality factors been negligible in their operation during the period of population increase following introduction, there must have been a very large absolute number of the insects present in the area for at least several seasons prior to 1947. That they were not collected then suggests that the behaviour of the species may be influenced by its population density.

Acknowledgements.

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The figures were drawn by Mr. L. A. Marshall and photographed by Mr. D. H. Wilson (Division of Entomology, C.S.I.R.O.).

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