A FIELD KEY TO IDENTIFY SOME *RHINOCEROS* AND OTHER BEETLE LARVAE BREEDING IN COCONUT PALM HABITATS IN PAPUA NEW GUINEA

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ABSTRACT

A practical field key to rapidly distinguish third instar Scapanes australis *(Boisduval) and* Oryctes rhinoceros *(L.) larvae along with seven scarabaeoid species in Coconut Palm and similar habitats is devised. Drawings and photographs of the larvae in support of the key are also presented.*

Keywords: *Scarabaeoidea, rhinoceros beetle, identification, third instar, coconut.*

INTRODUCTION

A number of species of family Dynastidae commonly known as Rhinoceros beetles attack coconuts world wide. *Scapanes australis* and *Oryctes rhinoceros* are the worst pests of coconut palms in Papua New Guinea and particularly damaging during the first ten years of planting. These insects are common on the island regions (East New Britain Province, New Ireland) where severe damage is continuously observed and does not allow coconut rehabilitation. In either case, if attack by the rhinoceros beetles is associated with damage by *Rhynchophorus bilineatus* (Montrouzier) (Coleoptera: Curculionidae), this leads to the death of the palm. Investigations into the biological control of these pests were undertaken on the mainland of Papua New Guinea where the level of *Scapanes australis* population is quite low as well as in East new Britain which is a badly affected area.

The aim was to identify some pathogenic agents found in the field in a wide variety of breeding sites many of which are still not well known. A correct identification of the pest species larvae, amongst other white grubs found in very similar habitats, was needed.

During field studies, several larvae were discovered which were similar in external appearance but belonged to different species. Confusion could easily occur between at least 9 different white grubs of superfamily Scarabaeoidea which occupy similar feeding habitat *viz.* organic matter and decaying wood. The different larvae were identified as *Scapanes australis* (Boisduval), *Oryctes rhinoceros* (L.), *Oryctes centaurus* (Sternb.), *Xylotrupes gideon* (L.), *Trichogomphus vicinus* (Dechambre), *Oryctoderus latitarsis* (Boisd.) (Coleoptera, Scarabaeidae, Dynastinae), Cetoninae (Coleoptera, Scarabaeidae) and Lucanidae (Coleoptera, Scarabaeoidea).

The first six species are considered either as pests of coconut palm or occasionally attacking it. For many years a number of larvae of these species were unknown or subjected to misidentification. Although the adult beetles are quite distinct, there was an apparent absence of visible characters to distinguish the larvae of such beetles for inexperienced people such as farmers, extension workers or even scientists, not used to identify immature insects. The larvae of alll the 9 species are very much alike, being whitist-creamy curl grubs, typical of family Scarabaeidae (Waterhouse 1987).

During the past thirty years, a number of scientific papers have been published to distinguish the larvae to family, subfamily and genus (Richter 1966) level.

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Taxonomic works based on setation to distinguish six of these Dynastine species exist (Bedford 1974). Descriptions have also been provided for *Oryctes monoceros* from Seychelles (Bedford 1979) using the method of description developed for Dynastinae larvae by Richter (1944; 1966). Many of these keys can be used to distinguish the *Rhinoceros* species. However, such keys are difficult to use by non-specialists as well as field workers. Few authors have tried to provide descriptions of the white grubs from viable morphological characters which may be seen unaided or by the use of a low power hand lens and even these are far from practical.

The under surface of the last adominal segment, called the raster was described for some French Scarabaeidae (Hurpin 1961), for root-feeding beetle larvae (Goddyer 1977) and for *Oryctes elegans* (Hurpin and Fresneau 1969). The crawling of the larvae was discussed by Hurpin (1961). The size of the larva and the head capsule aspect was examined by O'Connor (1953) and Hurpin and Fresneau (1970). Other morphological characters such as the sclerite lateral plate of the first thoracic segment were used to distinguish *Oryctes elegans*, *O. rhinoceros*, *O. monoceros* and *O. nasicornis* (Hurpin and Fresneau 1969, 1970).

The present investigation provides descriptions, illustrations and drawings of the nine common scarabaeoid species, for the third instar larvae to rapidly differentiate them from one another in the field in live specimens and without a hand-lens.

MATERIALS AND METHODS

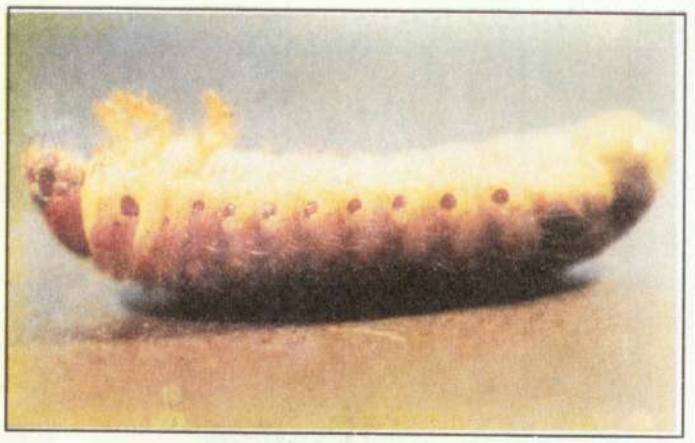
Field studies were carried out both on the mainland of Papua New Guinea during 1996 and 1997 and in East New Britain Province in 1996. On the mainland, Madang Province, including Karkar island and East Sepik Province were visited. In East New Britain, Keravat and Sigute sites were investigated. Inspections were centred around coconut plantations and inside the bush where felled trees, decaying logs, rotten wood and piles of organic matter are commonly used as breeding sites by *Rhinoceros* larvae. Third stage larvae were mostly hand-collected from their feeding habitat i.e from the medium they were found feeding on.

Field collected larvae were placed under ambient laboratory conditions (28-30^{0}C, 60-70% RH, natural photoperiod) inside different plastic buckets with their respective organic feeding medium. As the purpose of this paper is to provide a key to rapidly identify the larvae in the field, the live immature stages were studies first and then the dead specimen used for confirmation after additional observations and dissection.

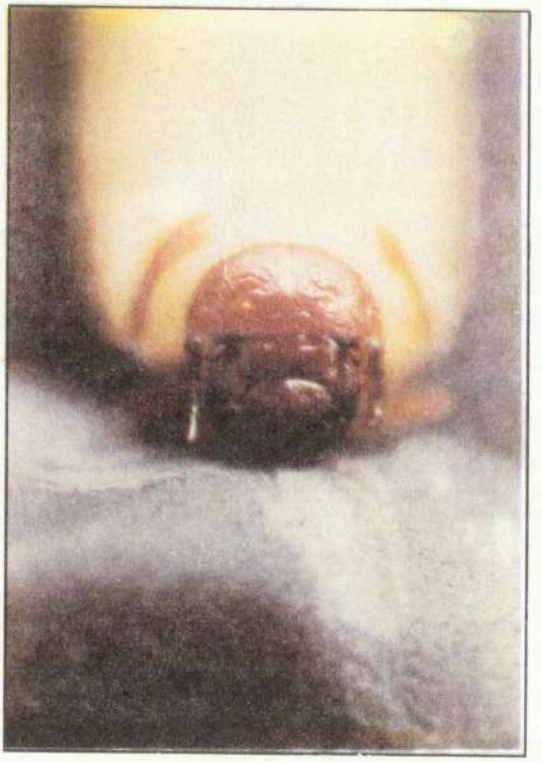
At the time of collection and in the laboratory, the behaviour of live larvae and general aspect (colour and hairiness) was observed by placing various batches of larvae on the ground to observe their movement and photograph them. In the laboratory, the specimens were stored for about 20 minutes (depending on the size of the specimens, usually 70 mm on an average) in cool conditions to keep the specimen inactive to get clear macrophotographs. Three different parts of the larvae were photographed: the head capsule, the ventral and the dorsal surface of the last adominal segment.

The ventral part of the last adominal segment, the anal opening and the first thoracic sclerite were observed under a binocular microscope and sketched. From each different group of larvae, two specimens were dropped alive into KAA fixative, left overnight until fixed and preserved in 80% ethanol in plastic containers (Norris and Upon 1974). Fixation in KAA reduces shrinkage and avoids black discoloration by inhibiting enzymatic activity and prserves the larva in a life-like condition.

To confirm that the white grubs belonged to the families of Scarabaeoidea, especially Scarabaeidae and the subfamily of Dynastidae, the most valuable distinguishing characters were found on the head and mouthparts as described by Richter (1966) and Baraud and Paulian (1982). Dynastinae were confirmed using Bedford's (1974) key. As soon as a larva died, the head capsule was sliced with a razor blade and stored in 80% ethanol. For microscopic observation, the head capsule was plunged into 10% Potassium hydroxide for 5 minutes under a gentle flame until it became transparent. After cooling and rinsing in alcohol, the complex of the maxillae, labium, antenna and mandible were removed to observe the characters described by Richter (1966) and Baraud and Paulian (1982).



a



b

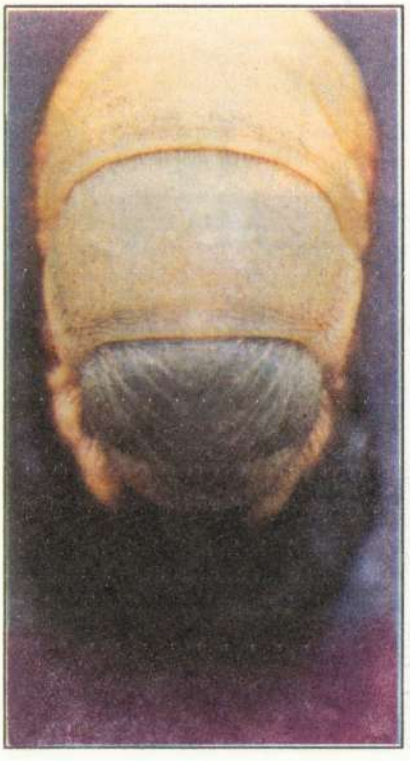
c

d

Plate 1. Larvae of Cetoninae

a

d



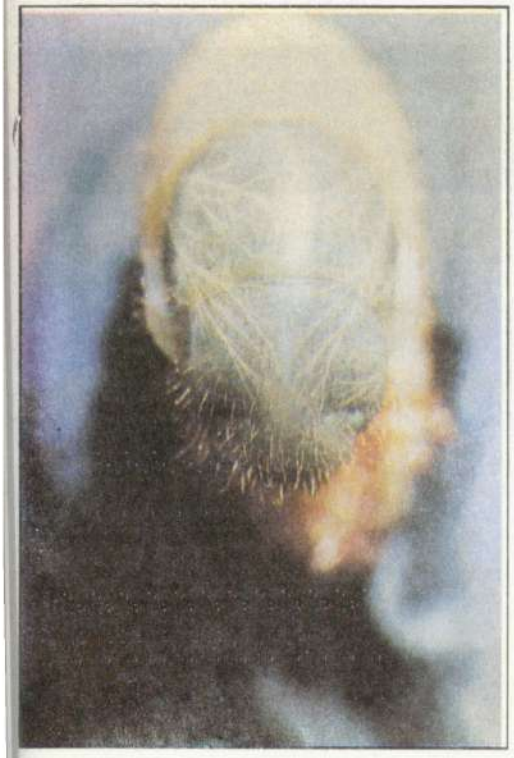
c

d

Plate 2. Larvae of *Xylotrupes gideon*

a

b



c

d

Plate 3. Larvae of *Oryctoderus latitarsis*

a

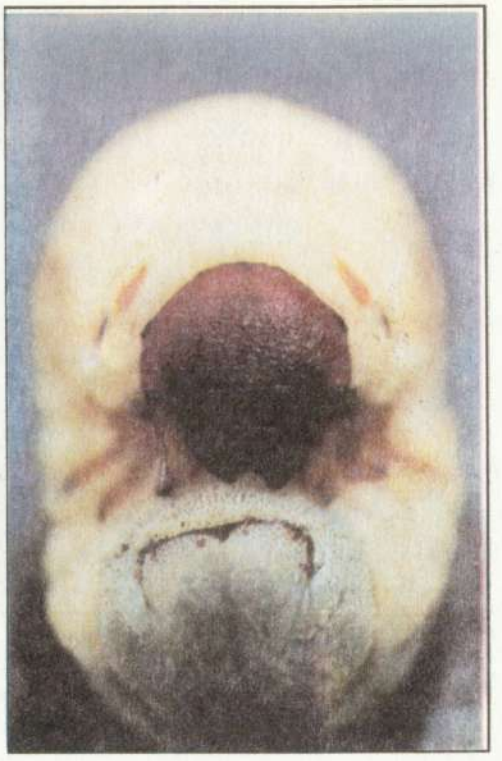
b

c

d

Plate 4. Larvae of *Trichogompus vicinus*

a



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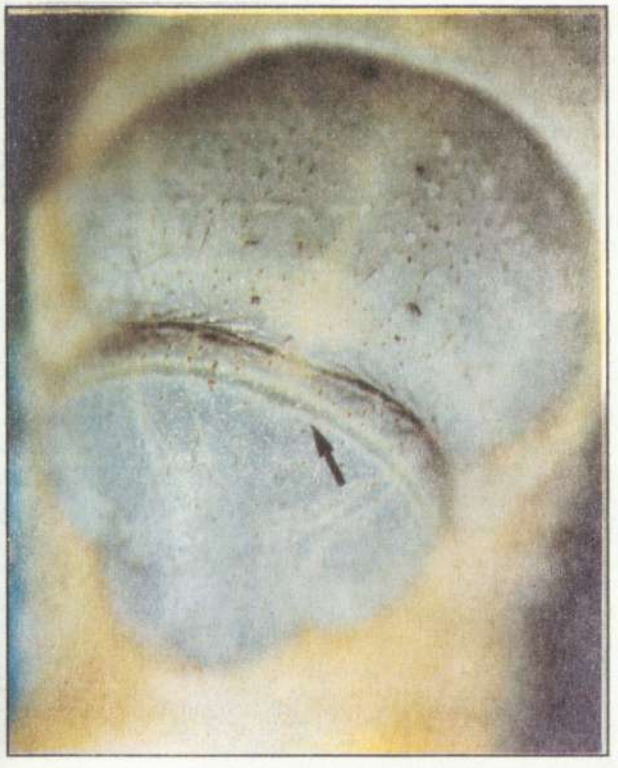


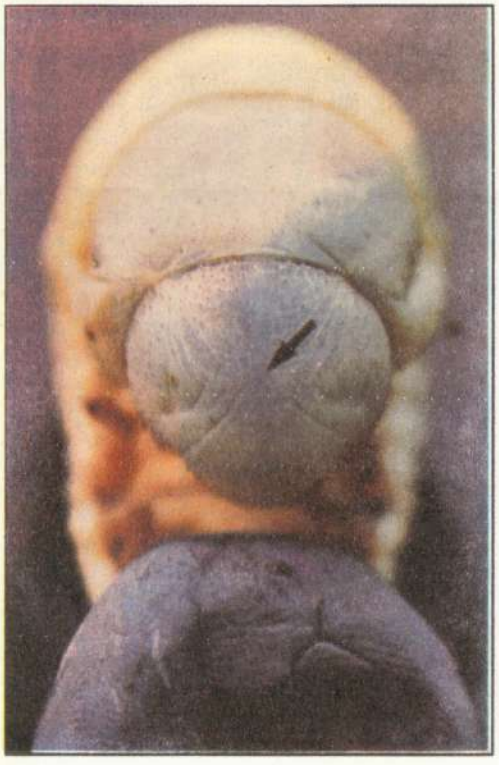
c

d

Plate 5. Larvae of *Oryctes rhinoreos*

a

b

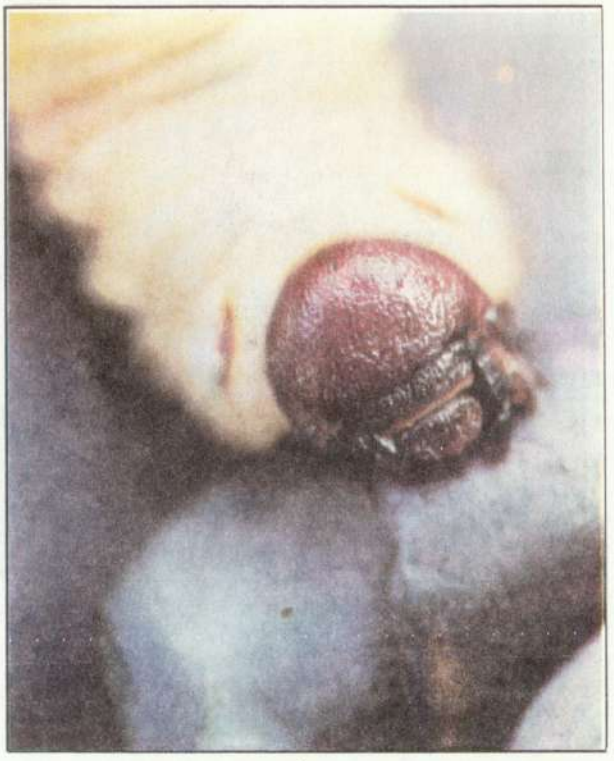


c

d

Plate 6. Larvae of *Oryctes centaurus*

a

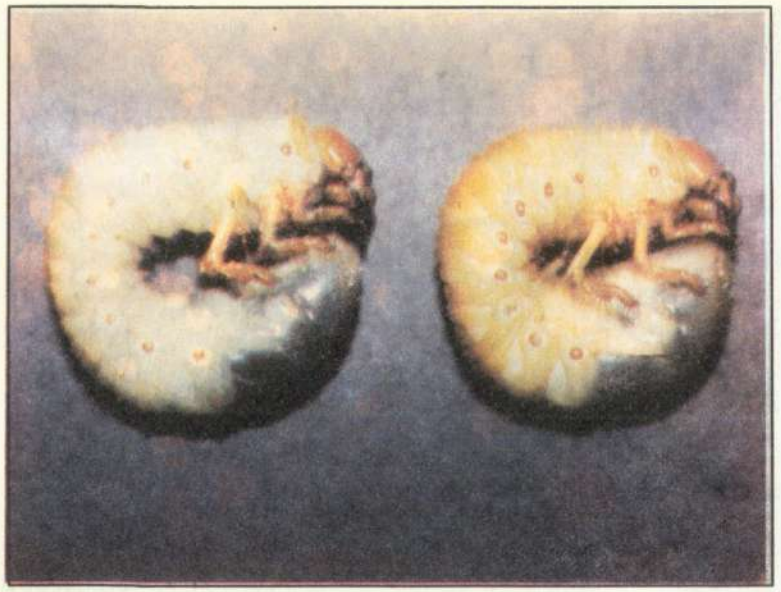


b

c

d

Plate 7. Larvae of ***Scapanes australis***



a

b

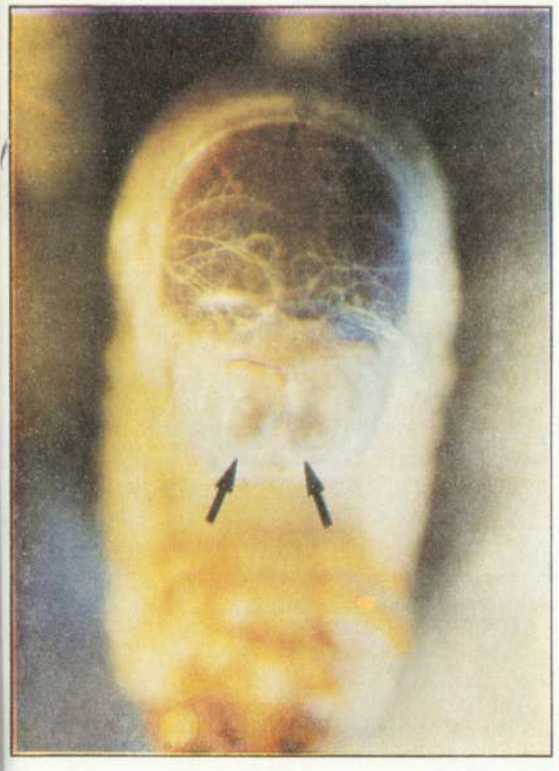
c

d

Plate 8. Larvae of *Dermolepida* spp.

a

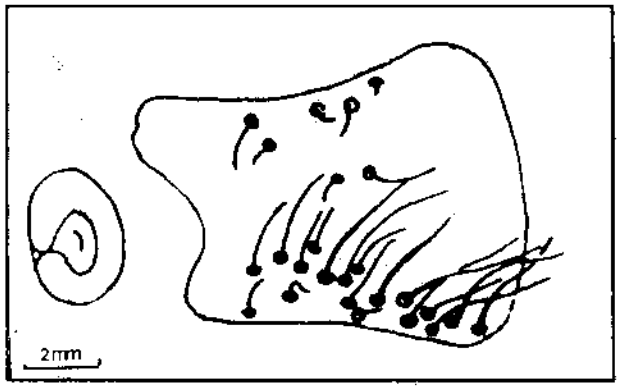
b



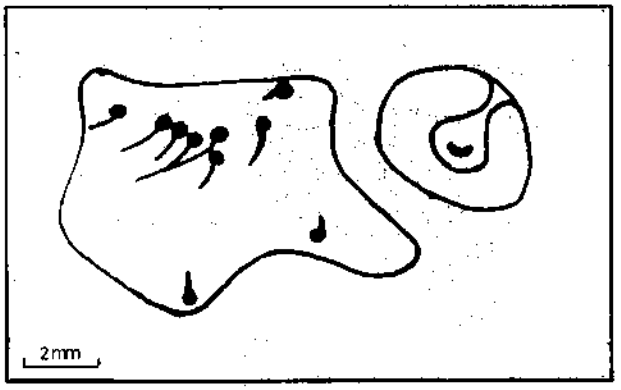
c

d

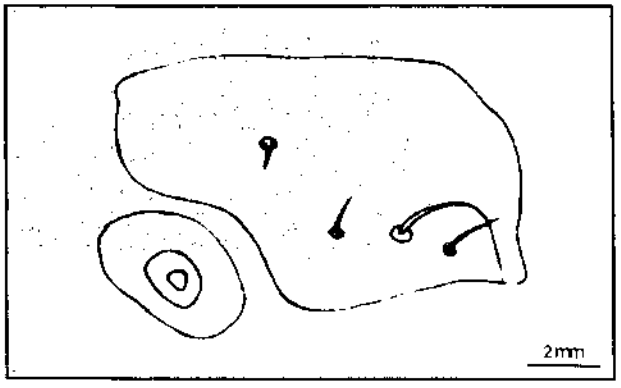
Plate 9. Larvae of Lucanidae



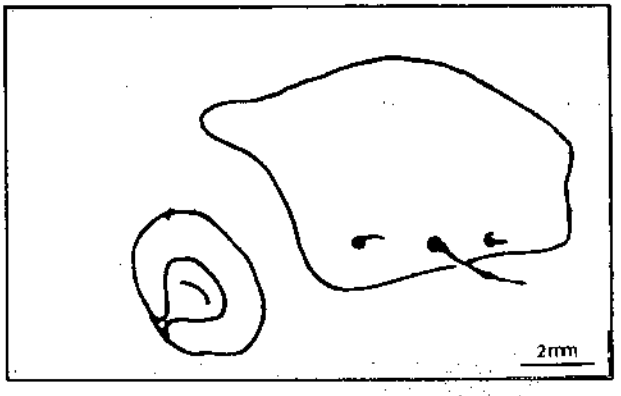
(a) *Xylotrupes gideon*



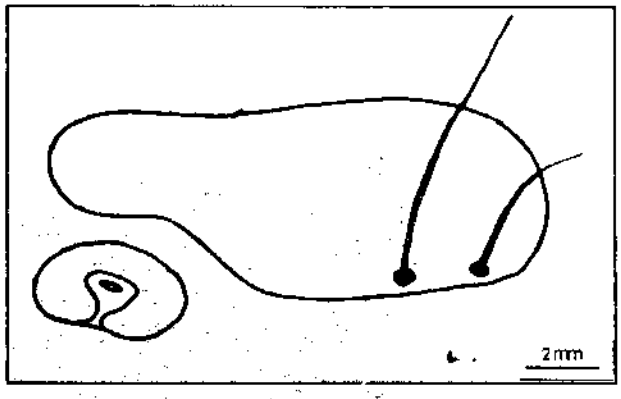
(d) *Oryctes rhinoreos*



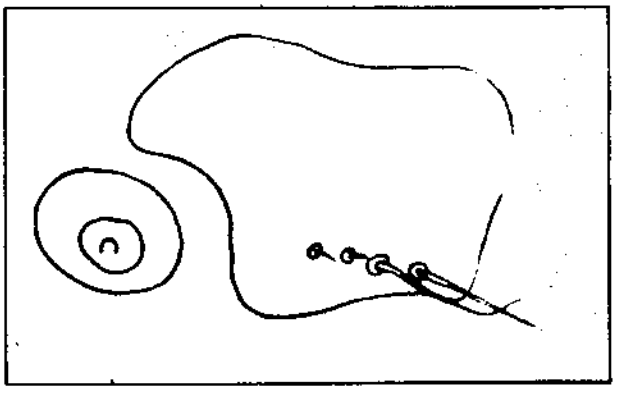
(b) *Oryctoderus latitarsis*



(e) *Oryctes centaurus*



(c) *Trichogompus vicinus*



(f) *Scapanes australis*

Figure 1. Thoracic sclerite plates and spiracles of various larvae.

RESULTS

At the beginning of the field work, it was observed that mixed collections of larvae behaved quite differently when placed live on flat ground. Any larvae which were not lying in a curled position were eliminated from the field collection. The rest were separable into three groups as soon as they moved.

1. The first group of larvae progress on their dorsal (back) surface (Plate 1 a) as previously described by Hurpin (1961) and Richter (1966). This character was sufficient to distinguish these Scarabaeidae from other larvae and to identify them as species of Cetoninae.

2. The second group of larvae progressed on their ventral (front) surface (Plates 2,3 a). These larvae could then be further separated into two different genera, mainly on the colour of the body hairs and head capsule colour (Plates 2 a, 2 b, 3 a, 3 b), and finally on the number and type of hairs on the first thoracic sclerite (Figure 1 a, 1 b). This group of larvae were identified as *Xylotrupes gideon* and *Oryctoderus latitarsis*.

3. The third group of larvae which were usually the most numerous in the field collections, only moved on their side, in a crab like progression (Plates 4,5,6,7,8 and 9 a). These were more difficult to separate using nothing more powerful than a pocket lens.

The examination of the head capsule colour and the anal (last segment) end in the third group reveals diagnostic features which are described and illustrated in the key. A black head capsule was observed for *Trichogomphus vicinus* (Plate 4 b). A ring, present as a dorsal impressed line on the last abdominal segment was found to be a characteristic of *Oryctes rhinoceros* (Plate 5 c). A depressed longitudinal line on the dorsal side of the last abdominal segment was observed for *Oryctes centaurus* (Plate 6 c). An arrangement of two rows of spines revealed Dermolepida (Melolonthinae) larvae (Plate 8 d) whereas two characteristic anal lobes with Y-shaped anal opening were features of the Lucanid species (Plate 9 d).

The length and number of setae on the first thoracic sclerite and the spiracles were also characteristic for species such as *Xylotrupes gideon, Oryctoderus latitarsis, Trichogomphus vicinus, Oryctes rhinoceros, Oryctes centaurus* and *Scapanes australis* (Figures 1 a, b, c, d, e, f). Using a combination of these characters, which can be seen using a hand lens, identification can be confirmed.

It is important to note that this key is designed to be used for the larger larval instars (3rd instar and beyond) and only those found, feeding on organic matter or in contact with the soil and lying in a curled position. When using the key, a larva that does not exactly fit the description given in the key, can be assumed to be another species not commonly found in the described situation, and probably not a scarabaeoid larva.

Field key to distinguish some third instar white grubs of Scarabaeoidea in PNG.

1. Live larvae, when placed on a flat surface, uncurl and move on their dorsal surface (plate 1 a.).....**Cetonidae**

1' Live larvae when placed on a flat surface, uncurl and move on their venral side (plates 2,3 a).....**2**

1" Live larvae when placed on a flat surface, uncurl and move on their side in a crab-like progression (plates 4, 5, 6, 7, 8, 9 a) **3**

2(1') First thoracic sclerite with 13-32 medium to long red setae. Body covered with red setae. Head capsule reddish brown (plates 2 a, b, fig. 1 a) ....***Xylotrupes gideon***

2' First thoracic scierite with one long seta, one to two medium setae plus one to four short setae. Head capsule brown colour (plate 3 b, fig 1 b) .....***Oryctoderus latitarsis***

3(1") Head capsule black. First thoracic sclerite with 2 long setae (plate 4 b, fig 1 c)..... .....***Trichogomphus vicinus***

3' Head capsule reddish brown (plates 5, 6, 7 b) **4**

3" Head capsule orange-reddish (plates 8, 9 b) **7**

4(3') Distinctive ring or saddle on anal segment. First thoracic segment with one long, 3-8 medium length setae, shorter than width of sclerite (plate 5 c, fig. 1 d).....***Oryctes rhinoceros***

4' No distinctive ring or saddle on anal seg-

ment (plates 6, 7 c).....5

5(4') Presence or absence of a longitudinal depressive line in the middle of the dorsal anal segment. Thoracic spiracles more or less differentiated in their form and colour.

First thoracic sclerite with 1 to 2 prominent setae longer than width of sclerite. First thoracic sclerite with more than 2 prominent setae which are shorter than width of sclerite.....6

6(5) Presence of a longitudinal depressed line in the middle of the dorsal anal segment.
Thoracic spiracles well differentiated in their form and colour (fig. 6 a).

First thoracic sclerite with 1 prominent seta, longer than width of sclerite plus one or two short setae (fig. 1 e).....***Oryctes centaurus***

6' Absence of a longitudinal depressed line in the middle of the dorsal anal segment.
Thoracic spiracles uniformely dark brown in colour (fig. 7 a)
Thoracic sclerite with 2 prominent setae, longer than width of sclerite plus two minute setae or empty setal sockets (plate 7 c. fig. 1f) .....
.....***Scapanes australis***

7(3") Characteristic design present on the ventral face of the raster (plate 8, 9 d).....8

8(7) Two rows of setae (plate 8 d).....
.....***Dermolepida* spp.**

8' Two rows of setae and anal opening Y-shaped (plate 9 d).....***Lucanidae.***

CONCLUSIONS

The results of our observations allow the use of simple characters to easily identify in the field the third stage of larvae similar morphologically and occupying similar breeding sites. This key does not require the use of complicated identification features as previously published. The first main character to observe in live specimens is the crawling movement of the larvae on a solid and flat surface. The readily visible characters are then compared. Colour of the head capsule (black for *Trichogomphus vicinus*), particularly important setation (*Xylotrupes gideon*), presence of a specific ring on the last ventral abdominal segment (*Oryctes rhinoceros*), design of the raster (*Demolepida* spp., Melolonthinae and Lucanidae), and characteristic spiracles and sclerite setation separate *Oryctes centaurus* and *Scapanes australis*.

In order to consider using biological control against coconut rhinoceros beetle pests, their numbers and distribution need to be determined. Collection of diseased larval specimens in the field requires identification and testing against other related species before any multiplication and introduction into the islands. This field key enables both experienced entomologists and the field staff to collect and identify the species being studies for biological control.

ACKNOWLEDGEMENTS

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REFERENCES

BARAUD J. and **PAULIAN R.** (1982). Faune des Coleopteres de France 2 Lucanoidea et Scarabaeoidea XIX pans Lechevallier 477p.

BEDFORD G.O. (1979). Description of the larva of *Oryctes monoceros* (Olivier) (Coleoptera, Scarabaedae, Dynastinae) from the Seychelles *Bull. Ent. Res.* 69:599-604.

BEDFORD G.O. (1974). Descriptions of the larvae of some rhinoceros beetles (Coleoptera, Scarabaeidae, Dynastinae) associated with coconut palms in New Guinea. *Bull. Ent. Res.* 63:445-472.

ENDRÖDI S. (1957). Rassenkreis von *Scapanes australis* Boisd. (Coleopt., Dynastinae) *Bonn zool Beitr* 8:71-74.

GODDYER, G.J. (1977). Root-feeding beetle larvae-pests of crops and pastures. *Agricultural Gazette, New South Wales* 88:(5) 42-43.

HURPIN, B. (1961). Sachons distinguer entre les nombreuses espèces de vers blancs, *Ptytome*, 129: 11-16; 130:23-27.

HURPIN, B. and FRESNEAU, M. (1969). Contribution à l' étude des *Oryctes elegans* (Col. Dynastidae). *Ann. Soc. Ent. fr.* (N.S.) 5(3):595-612.

HURPIN, B. and FRESNEAU, M. (1970). Etude en labrtoire du dévelopement larvaire de *Oryctes monoceros* et Oryctes rhinoceros (Col. Scarabaeidae). *Ann. Soc. Ent. Fr.* (N.S.) 6(1): 193-214.

LEPESME, P. (1947). Les insectes des palmiers. Paris: Lechevallier. 903 p.

NORRIS, K.R. and **UPON, M.S.** (1974). The collection and preservation of insects. Brisbane: Australian Entomological Society. Miscellaneous Publication 3, 33pp.

O'CONNOR, B.A. (1953). The rhinoceros beetle (*Orycles rhinoceros* L.) in Fiji. *Fiji Agricultural Journal* 24(1-2):1-12.

RICHTER, P.O. (1966). White grubs and their allies. Corvallis; Oregon State University Press. 219 p.