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A note on the larval host plant and biology of the Australian jewel beetle *Astraeus crassus* Van de Poll (Coleoptera: Buprestidae)

With 1 Figure and 1 Table

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Abstract: New observations are provided here on the larval and pupal chambers of the Australian buprestid beetle, *Astraeus crassus* Van de Poll (Coleoptera: Buprestidae). The native plant *Bursaria spinosa* Cav. (Pittosporaceae) is confirmed as the only known larval host plant for *A. crassus*. Biological/host plant data are compared with those of other *Astraeus* species. A possible evolutionary scenario concerning the host plant relationships of *A. crassus* is briefly outlined and discussed.

Zusammenfassung: Neue Beobachtungen über Larvenstadien und Puppenwiegen des australischen Prachtkäfers *Astraeus crassus* Van de Poll (Col.: Buprestidae) werden hier vorgestellt. Die bodenständige *Bursaria spinosa* Cav. (Pittosporaceae) wurde als einzige bekannte Wirtspflanze der Larven von *A. crassus* ermittelt. Die Beobachtungen über Biologie und Wirtspflanze des Käfers werden mit denen anderer *Astraeus*-Arten verglichen. Gesichtspunkte der möglichen evolutionären Entwicklung der Wirtspflanzen-Beziehung von *A. crassus* werden kurz herausgestellt und diskutiert.

Introduction

The genus *Astraeus* Laporte & Gory contains about 50 species of mostly small to medium-sized, brownish-black and yellow buprestids occurring throughout Australia and in New Caledonia (CARTER 1929; BARKER 1975). Apart from scattered data on supposed adult host/food plants, almost nothing has been recorded on the biology of the various species of *Astraeus* (HAWKESWOOD 1978; HAWKESWOOD & PETERSON 1982). Adults of *Astraeus* are characterized by the presence of a spring mechanism, involving the release of the elytra from the closed position; when the beetle releases the spring, the elytra flick open with considerable force, enabling the insect to be flung upwards (BARKER 1975; HAWKESWOOD 1978). *Astraeus crassus* Van de Poll is one of the largest species in the genus and has been mainly recorded from eastern New South Wales where adults are often locally common on species of *Casuarina* (Casuarinaceae). Recent observations on the larval/pupal chambers and larval host plant of *A. crassus* are recorded and discussed below.

Observations

On 5 Nov. 1994 at 10.30 hrs (Eastern Australian Summer Time), the senior author visited a mature stand of *Casuarina torulosa* Ait. (Casuarinaceae) at Lapstone, 5 km west of Penrith, New South Wales, (c. 33° 42′ S, 150° 39′ E), in order to collect specimens of *Astraeus* species for taxonomic research being undertaken by the authors (a description of this habitat and buprestids previously collected from this area are provided by HAWKESWOOD 1978). One specimen each of *A. crassus* Van de Poll and *A. pymaeus* Van de Poll were observed on a branch of *C. torulosa* (about 4 m high) at about 1.7 m above ground level. These beetles were not collected and no others were observed in the area. However, during a complete search of the site, a number of mature *Bursaria spinosa* Cav. (Pittosporaceae) shrubs were

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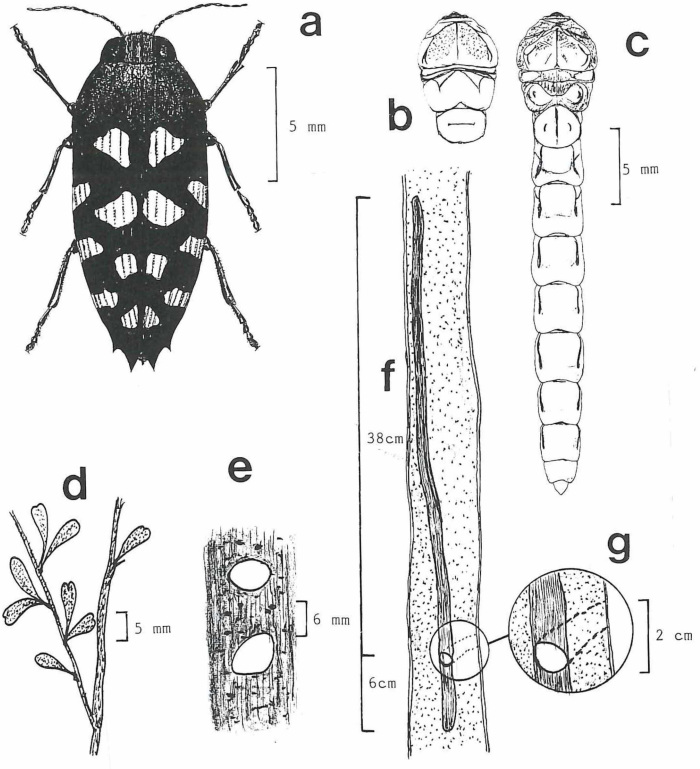

Fig. 1. *Astraeus crassus* Van de Poll and larval host plant, *Bursaria spinosa* Cav. a: adult *A. crassus,* dorsal view; b: ventral view of head and thoracic segments of last instar larva; c: dorsal view of last instar larva; d: part of branchlet of *Bursaria spinosa;* e: exit holes of *A. crassus,* male (top), female (bottom); f: larval chamber of female situated in dead branch of *B. spinosa;* g: detail of typical exit tunnel from larval chamber. (Illustration: J. R. TURNER)

noted and an examination of some of them which were situated in a powerline corridor at the northern end of the area, revealed a number of emergence holes which were typical of Australian Buprestidae in shape. A 4-metre long billet was collected for later dissection, which resulted in the acquisition of a number of larvae (Fig. 1 b, c) measuring 3 – 30 mm in body length and two dead males and one dead female *A. crassus* (Fig. 1 a). On 6 Nov. 1994 at 10.00 hrs (EAST) on an overcast morning with gale force winds, a second visit to the area by the senior author was undertaken in order to search for more buprestid material. Three more billets of *B. spinosa* were gathered from the powerline corridor and taken for dissection; this resulted in the extraction of another 5 dead male and two dead female adults of *A. crassus* along with 8 larvae, several of which measured 40 mm in length. In addition, two live adults of *A. crassus* were collected from a 2 metre tall *C. torulosa* bush situated on the eastern boundary of the area on the same day. During later dissection of the billets, a number of observations were made. It was noted that the exit (emergence) holes (Fig. 1 e) of the males were all positioned at 0° to the latitudinal axis of the host branch and measured mostly 6 mm × 5 mm, while those of the females were all positioned about 45° to the latitudinal axis and were larger, measuring 8 mm × 6 mm (see Fig. 1 e). The typical larval chamber (Fig. 1 f) measured 40 – 50 cm in total length, with the upper 20 cm portion situated 2 – 3 mm below the bark; about 20 cm distance down the stem the chamber moved gradually to the centre of the stem for about 25 cm. The emergence tunnels left the main central chamber at about 6 cm from the lowermost portion and at an angle of about 45° to the longitudinal axis of the branch

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(Fig. 1, f,g). Some of the larval chambers were single, i.e. not anastomosing, but many others were grouped and sometimes joined in certain places. Many of the shorter larval chambers did not contain any larvae. No other species of buprestied or wood-boring invertebrates were found to utilize the *B. spinosa* wood, except for several specimens of one species of an unidentified small wasp or fly which were resting in their larval chambers. More adult *A. crassus* were observed in the area when another visit was undertaken on 10 Nov. 1994. Three adults were observed on the branches of a 2.5 m tall *C. torulosa* tree whose branches were interwined with *B. spinosa,* from which one of the billets was collected on 6 Nov. One other *A. crassus* was observed on a 4 m tall *C. torulosa* on the eastern boundary of the area about 20 m from where the two species of *Astraeus* were collected on 6 Nov. 1994.

During 12 – 14 Nov. 1994, the senior author visited the Charleyong area in southern New South Wales as part of a National Parks Association Biodiversity Team surveying the area where the Mongarlowe River joins the Shoalhaven River (c. 35° 15′ S, 149° 55′ E). On 13 Nov. 1994, an adult *A. crassus* was found resting on a branch of a 2 m tall *C. nana* Sieb. ex Spreng. in the bed of the Mongarlowe River 2 km from where it joins the Shoalhaven River and a search of the river bank in the adjacent area resulted in a number of *B. spinosa* bushes being located. When examined, several of these bushes were found to have exit holes identical to those found at Lapstone Hill. On 14 Nov. 1994, JRT found an adult of *A. crassus* at rest on a branch of *Acacia trachyphloia* Tindale (Mimosaceae) at a height of about 2 m, with its head facing towards the main stem of the tree which had grown to about 3.5 m high and was located on the western bank of the Shoalhaven River about 3 km downstream from where the Mongarlowe River joins it. As there was no *B. spinosa* on this side of the river, it was possible that this beetle may have flown from across the river where the vegetation had not been cleared.

On 1 Feb. 1995, JRT visited the Brewongle Field Studies Centre at Lower Portland, New South Wales (33° 25′ S, 150° 45′ E) and found a number of *B. spinosa* bushes. Several of these possessed exit holes which were identical to those found at the other localities, i.e. smaller holes at 0° and larger holes at 45° to the latitudinal axis of the host timber (see Fig. 1 f). A species of *Casuarina* (probably *C. torulosa*) also occurred at this site.

Discussion

Little is known of the larval host plants of *Astraeus* species. The presently known or purported larval hosts and references for *Astraeus* are outlined in Table 1. The first published larval host record for an *Astraeus* species appears to be that of GOUDIE (1920), in a paper that has been overlooked or ignored by most later authors dealing with the Australian Buprestidae. His record of *Casuarina leuhmanniana* has not been confirmed by later workers and there are no further records of *Astraeus* breeding in this tree species. Despite these facts, we have retained the record as valid in Table 1.

It was another 60 years before HAWKESWOOD (1985) recorded the next larval host for *Astraeus*. HAWKESWOOD (1985) noted the unusual occurrence of adults and larvae of *A. crassus* Van de Poll in the dead or dying branches of *Bursaria spinosa* Cav. (Pittosporaceae) at Bakers Creek Falls in the Armidale area, north-eastern New South Wales. This record was very interesting since *Astraeus* are mostly found on species of *Casuarina* (TEPPER 1887; BARKER 1975; HAWKESWOOD 1978; WILLIAMS & WILLIAMS 1983), and it was supposed by many entomologists (HAWKESWOOD, pers. comm.) that the larval hosts of *Astraeus* were mostly likely to be *Casuarina*. The recent, important observations by JRT reported here confirm the larval host of *Bursaria spinosa* first found 10 years ago by HAWKESWOOD (1985). Adults of *A. crassus* are typical of the genus in being found on foliage or stems of *Casuarina;* they are not usually found on *Bursaria*. At least three adult "hosts" have been reported in the literature to date and there are a number of unpublished records. The previously published adult hosts are *Casuarina littoralis* Salisb. (BARKER 1975; WILLIAMS & WILLIAMS 1983),

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Table 1. Summary of the known or purported larval host plants and references for *Astraeus* Laporte & Gory

Buprestid species	Larval host plant	Host plant family	Reference
Astraeus crassus Van de Poll	*Bursaria spinosa* Cav.	Pittosporaceae	Hawkeswood (1985); Turner & Hawkeswood (this paper)
Astraeus irregularis Van de Poll	*Casuarina leuhmanniana* R. T. Baker	Casuarinaceae	Goudie (1920); Hawkeswood & Peterson (1982)
Astraeus mastersi Macleay	*Eucalyptus propinqua* Deane et Maiden	Myrtaceae	Hawkeswood (1986)
Astraeus prothoracicus Van de Poll	+ *Banksia prionotes* Lindl.	Proteaceae	Hawkeswood & Peterson (1982); Hawkeswood (1987)

+ Note: Plant oviposition record only; larvae have not yet been verified breeding in the cones of this species of *Banksia*, but the circumstantial evidence appears strong

C. leuhmanniana Miq. (Hawkeswood 1993) and *C. cunninghamiana* Miq. (Williams & Williams 1983). The data presently available suggests that *A. crassus* utilizes two species of flowering plant during its life-cycle. It is probable that *Casuarina* was the primordial host for *Astraeus*, but that over geological time, several species of *Astraeus* have shifted their larval host preferences to other non-related plants. This case scenario appears to have occurred with *A. crassus*. There is presently no evidence to suggest that this beetle breeds in *Casuarina*, but adults appear to still utilize *Casuarina* as mating and resting sites; the thin *Casuarina* needles may play some role in nutrition but feeding observations have yet to be forthcoming. *A. crassus* adults are probably active during the day on *Casuarina* where they at least mate (mating pairs have been observed by the authors on *Casuarina*) and egg-laying on *Bursaria* probably takes place during the night. Since *Bursaria* are prickly shrubs, sites for egg-laying by large buprestids such as *A. crassus* are restricted to dead branches which may have lost most of their thorns. We postulate here that with the above in mind, *A. crassus* will be found (or be restricted to) localities where both *Casuarina* and *Bursaria* spinosa occur sympatrically (This is the case with the three sites from southern eastern New South Wales mentioned in this paper as well as the site in the Armidale area mentioned by Hawkeswood 1985).

Hawkeswood & Peterson (1982) noted that the genus *Casuarina* contains about 70 species, distributed in Malaysia, Madagascar, Polynesia and Australia (which has at least 30 described species, often placed in the genus *Allocasuarina*). Hawkeswood & Peterson (1982) also noted that the present disjunct distribution of *Casuarina* can be partly explained by the break-up of Gondwanaland where the genus probably originated about 100 million years BP. In addition, Raven & Axelrod (1974) stated that it was likely that the ancestors of the ancient and archaic Casuarinales reached Australia during mid-Cretaceous geological time, c. 100 million years BP. In Australia, *Casuarina* species are present in the fossil pollen records of rocks of the Palaeocene epoch (66 – 24 million years BP) (White 1990). The Tertiary is usually regarded as a most significant period of geological time when aridity became the main factor affecting the Australian environment, which resulted in the establishment of an arid interior to the continent, the spread of scrub and grasslands and the contraction of rainforest and the evolution of sclerophyllous vegetation (White 1990). *Casuarina* is well represented in the fossil flora of this period of geological time. It is probable that much speciation of *Astraeus* in the arid and semi-arid areas of Australia occurred at this time when *Casuarina* was also evolving and speciating. The association of *A. crassus* with *B. spinosa* is probably also relatively ancient since this plant appears to have evolved likewise during drier times in woodlands and dry sclerophyll forests from rainforest taxa (possibly *Citriobatus* to which *Bursaria* is closely related). On the other hand, the shift of *A. crassus* from *Casuarina* to *Bursaria* as a larval host may have been a more recent event. Presently, the number of wood-boring Coleoptera known to utilize the dead timber of *B. spinosa*

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is very few (HAWKESWOOD & TURNER, unpub. data) (although a large number of Coleoptera and other insects are attracted to its flowers (HAWKESWOOD 1990)).

Thus *B. spinosa* represents a potential source of food for developing insects which appears to have been underutilized by the native wood-boring beetle fauna of Australia. Why this is so remains a mystery, but perhaps the plant's chemical and physical defenses have greatly restricted the incidence of host utilization. Further observations on the biology, behaviour and hosts of *Astraeus* and fossil evidence would shed much needed light on their plant associations and evolution.

Another interesting observation made by JRT is the apparent dimorphism in exit hole orientation in respect to the latitudinal plane of the host wood. The male exit hole is situated with its longitudinal axis (defined here as the longest axis as the holes are ± elliptical) parallel (0°) to the latitudinal axis of the branch, while the female exit hole is at or about 45°. The significance of this phenomenon is not known and has not been reported previously for any Australian Buprestidae.

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