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Review of the biology, host plants, behaviour and parasites of the Australian buprestid beetle, *Diadoxus erythrurus* (White) (Coleoptera: Buprestidae)

With 3 Figures

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Abstract: The biology, host plants, behaviour and parasites of the Australian jewel beetle, *Diadoxus erythrurus* (White) are reviewed from the published literature. The presently known larval hosts are the native cypress pines, *C. endlicheri* (Parlatore) F. M. Bail., *Callitris glaucophylla* Thompson & Johnson and *C. preissii* Miq. subsp. *verrucosa* (A. Cunn. ex Endl.) J. Gardner (Cupressaceae) and the introduced *Cupressus macrocarpa* Hartweg var. *lambertiana* Gordon (Cupressaceae). Other records refer to "*Callitris* spp." or "*Cupressus*" spp. as larval hosts. The adults usually frequent the foliage of their larval hosts where they are procryptically camouflaged through resting posture and colour pattern. The species has a very widespread distribution within Australia, being known from Queensland, New South Wales, South Australia and Western Australia.

Zusammenfassung: Über Biologie, Wirtspflanzen, Verhalten und Parasiten des australischen Prachtkäfers *Diadoxus erythrurus* (White) wird eine Übersicht gegeben. Gegenwärtig bekannte Wirtspflanzen der Larven des Käfers sind die bodenständigen Zypressengewächse *Callitris endlicheri* (Parlatore) F. M. Bail., *C. glaucophylla* Thompson & Johnson und *C. preissii* Miq. subsp. *verrucosa* (A. Cunn. ex Endl.) J. Gardner (Cupressaceae). Andere Berichte verweisen auf „*Callitris* spp." oder „*Cupressus*"-Arten als Wirtspflanzen der Larven. Die adulten Tiere halten sich gewöhnlich im Laub der Wirtspflanzen ihrer Larven auf, wo sie durch Ruhestellung und Färbung in Tarntracht (Mimese) leben. Die Arten sind in Australien sehr weit verbreitet; sie sind aus Queensland, Neusüdwales, Südaustralien und Westaustralien bekannt.

Introduction

The genus *Diadoxus* Thomson is a small genus of three species endemic to Australia (CARTER 1929; PETERSON & HAWKESWOOD 1980). They are commonly known as cypress pine buprestid beetles since the larvae of two of the species [viz. *D. erythrurus* (White) and *D. regius* Peterson – the latter species was previously known as *D. scalaris* Laporte & Gory; see PETERSON (1991) for taxonomic details], have been found to feed in the conductive tissues of the branches and trunks of native cypress pines (*Callitris* species, Cupressaceae). BLACKBURN (1899) described the third species, *D. jungi* Blackburn from Yorke Peninsula, South Australia, but did not record any biological observations. SAUNDERS (1868) provided redescriptions of *D. erythrurus* and *D. regius* (as *D. scalaris*), but also did not provide any biological data on the species. Attack on *Callitris* spp. by *D. erythrurus* was first recorded by VON LENDENFELD (1885) in western New South Wales. Since then, biological data and other observations on *D. erythrurus* have been provided by TEPPER (1887), FRENCH (1911), FROGGATT (1907, 1923, 1925, 1927), GOUDIE (1920), TILLYARD (1926), PESCOTT (1932), MCKEOWN (1942), ZECK (1955), BRIMBLECOMBE (1956), ANON. (1958), HADLINGTON & GARDNER (1959), MOORE (1972), PETERSON & HAWKESWOOD (1980), HAWKESWOOD & PETERSON (1982) and HAWKESWOOD (1980, 1985, 1987). These papers and books are reviewed here in the following section.

Literature review

(a) General Biology

As noted above, attack on *Callitris* spp. by *D. erythrurus* was first recorded by VON LENDENFELD (1885) in western New South Wales. When investigating the incidence of *D. erythrurus* in the Lachlan River area, VON LENDENFELD (1885) noted a correlation between low rainfall and the abundance of the beetle. He recorded that in 1883, *Callitris* spp. had taken possession of areas near the Lachlan River, overtaking the broad-leaved tree species which had previously constituted the forest. VON LENDENFELD (1885) further stated that official rainfall data were not available for inland areas for that period and consequently correlated Sydney rainfall figures to that of the interior, suggesting that the lower rainfall recorded in Sydney indicated a drought for that area. For the period 1840 to 1863 (Sydney rainfall during that period was 48 inches or 1220 mm), VON LENDENFELD (1885) indicated that *D. erythrurus* was not abundant; from 1862–1880 (Sydney rainfall 55 inches or 1400 mm), he stated that *Callitris* spp. were spreading, and for the period 1880–1884 (Sydney rainfall 40 inches or 820 mm), he observed that *Callitris* spp. were being heavily attacked by *D. erythrurus*. VON LENDENFELD (1885) concluded that periods of low rainfall are favourable to *D. erythrurus*, while periods of high rainfall favour the growth of *Callitris* spp. and reduce the incidence of *D. erythrurus*.

TEPPER (1887), in a reference overlooked by all subsequent researchers, briefly mentioned that *D. erythrurus* had the same habits as the related species, *D. scalaris* Laporte & Gory, for which he stated that the larvae breed in the heartwood of the older trees of *Callitris preissii* Miq. subsp. *verrucosa* (A. Cunn. ex Endl.) J. Gardner (Cupressaceae) (cited as *C. verrucosa*) in South Australia. TEPPER (1887) also noted that *D. erythrurus* was scarcer than *D. scalaris*, a situation which is usually reversed in other areas within the range of *D. erythrurus*.

The next author to comment on the biology of *D. erythrurus* was FROGGATT (1907) who briefly noted that the genus *Diadoxus* contained two very distinct species [he was obviously unaware of BLACKBURN's (1899) species *C. jungi*!], the larvae of which mainly frequent the stems of the native cypress pines (*Callitris* species) and sometimes attack and destroy introduced pine trees [genus of pine not specified by FROGGATT but probably *Cupressus* sp. (Cupressaceae), or *Pinus* sp. (Pinaceae)]. FROGGATT (1907) further noted that the larvae of *D. erythrurus* first feed under the bark, cutting the sapwood, and when the infested tree is small, the larval feeding often causes it to snap off.

FRENCH (1911), without any reference to previously published research on the species, noted that *D. erythrurus* was very destructive to the Murray Pine (*Callitris columellaris* F. Muell., as this taxon was previously known), and believed that Mulga (*Acacia aneura* F. Muell., Mimosaceae) and "other stunted" *Acacia* species, were additional hosts, although as pointed out by HAWKESWOOD & PETERSON (1982), this suggestion has never been verified or confirmed. FRENCH (1911) collected *D. erythrurus* in an area where no *Callitris* spp. or *Cupressus* spp. occurred and concluded that *Acacia aneura* was indeed a host plant for the larvae. The possibility that the beetles may have emerged from cypress pine brought into the area appears to have been overlooked [HADLINGTON & GARDNER (1959), commenting on FRENCH's (1911) observations]. HAWKESWOOD & PETERSON (1982) noted that there has never been any verification of FRENCH's record of *Acacia* as a larval host and that it was possible that the species had emerged from processed timber or had developed in *Pinus* or in other conifers in the area where FRENCH had collected. FRENCH (1911) also recorded the introduced tree *Cupressus macrocarpa* Hartweg var. *lambertiana* Gordon (erroneously listed as *C. lambertiana*) as a primary host for *D. erythrurus* from the Melbourne area, Victoria, noting that adults were often found in suburban gardens where they were responsible for the deaths of many ornamental trees growing in the streets. In one large *"Cupressus"*, FRENCH stated that he collected 37 adults as well as numerous larvae and pupae. FRENCH (1911) illustrated the larva for the first time, but it does not resemble the larva described by HAWKESWOOD (1985); perhaps the drawing was made from a shrivelled dried specimen.

GOUDIE (1920) very briefly noted that *D. erythrurus* bred exclusively in the Murray pine in Victoria (*Callitris glauca* Johnson & Thompson).

FROGGATT (1923, 1925, 1927) provided further details on the biology of *D. erythrurus* and these are summarised as follows: During early December, adult *D. erythrurus* emerge from trunks of dead trees or felled logs, cutting a clean hole through the outer surface of the dry bark; from one large log of *Callitris*, emergences continued from December to the end of January, the life-cycle appears to be at least one year duration, although there are often other larvae which remain in the wood until the following season; the females lay their eggs in the surface of the bark and the tiny larvae soon cut their way to the inner surface (interface of sapwood and cork cambium) where they remain to feed until fully grown; the larvae etch the outer surface of the sapwood, producing a slight scroll-like pattern while also gnawing the closely attached bark; thus the bark of an infested tree has the whole of its inner portion gnawed in wavy galleries which are firmly packed with wood dust (and faeces); it frequently has a variegated pattern where the brown bark dust and the outer yellow wood dust are packed in flattened galleries running side by side; during the early stages of their development, a large percentage of the early instar larvae are destroyed, especially those infesting felled logs which are stacked in yards of sawmills; mortality appears to be caused by moisture generated by the decaying bark which induces growth of fungi which eventually infect the beetle larvae; there are also a number of beetle predators and wasp parasites which destroy the larvae while they are under the bark and various larvae of the beetle family Cleridae, have been observed in the tunnels of the last instar larvae; when mature, the larvae cut narrow oval burrows into the sapwood; these burrows usually do not measure more than 2.5 cm in length, they are frequently much smaller, they are not closely packed with wood dust and they are often open under the bark; pupation occurs at the end of each burrow; the adult beetles often desert their native host plant species to infest the introduced hedge cypress, *C. lambertiana* (sic), and it is well known now that this hedge is seldom planted in areas where native cypress trees grow. (See also figure 1, this paper, from FROGGATT, 1927).

TILLYARD (1926) very briefly mentioned that *Diadoxus* are "attached to native and introduced pines".

PESCOTT (1932) noted that in northern and north-western areas of Victoria, the Murray Pine (*Callitris glaucophylla* Thompson & Johnson) (cited as *C. robusta* R.Br.) and the Mallee Pine (also *C. glaucophylla*) (cited as *C. robusta* R.Br. var. *microcarpa*) normally thrive in areas ranging from only a few trees to forests of several hundreds of trees, and that these cypresses were much sought after for building purposes, on account of the hard structure of the timber after seasoning

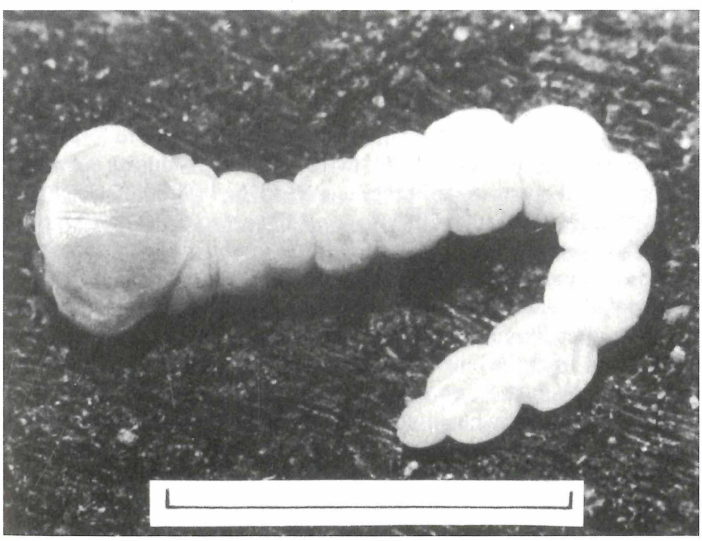

Fig. 1. Mature larva of *Diadoxus erythrurus* (White): dorsal view. (Bar indicates 10 mm). (Photograph: T. J. Hawkeswood, from HAWKESWOOD, 1985)

and also on account of the immunity of the seasoned timber to attack by insects, notably termites (cited as "white ants" (sic)). PESCOTT (1932) further mentioned that as a result of unfavourable conditions at certain times of the year, the cypress trees become weakened or debilitated, when they are then subject to attack by insect pests. This situation had arisen the previous winter when abnormal rainfall had caused the trees to produce a large amount of growth during the late winter and spring, which could not be maintained when the hot weather finally arrived. Hence the trees became very much weakened and in many areas died out as a result; those trees which did not die in the above manner were attacked by *D. erythrurus*, with the result that those trees were also destroyed (PESCOTT, 1932). Thus it was apparent that a wet winter followed by a hot summer caused mortalities of *Callitris* spp. in the mallee areas of Victoria and that certain trees weakened by excessive water were later attacked by *D. erythrurus* which finally caused their deaths (PESCOTT, 1932). Apart from those native cypress trees attacked by buprestids, there were also other trees in the mallee region reported to be attacked by *D. erythrurus*- many reports had been received by the Victorian Department of Agriculture to the effect that cypress trees grown for hedge and ornamental purposes (e.g. *Cupressus macrocarpa* Hartweg var. *lambertiana* Gordon) (cited as *C. lambertiana*) had been attacked by the buprestid (PESCOTT, 1932). In Western Australia, landholders had been advised not to plant *C. macrocarpa* where *Callitris* spp. had previously grown (PESCOTT, 1932). PESCOTT (1932) also cited the works of FROGGATT (1923) and FRENCH (1911) and briefly noted the taxonomic history of the insect, the adult colouration, the larval morphology and oviposition site and larval feeding [all covered by FRENCH (1911) and FROGGATT (1923, 1927)].

MCKEOWN (1942) was the next author to provide biological data on *D. erythrurus* but his account is a brief summary of the data provided by FROGGATT (1907, 1923, 1925, 1927) and as such, does not provide any new details.

ZECK (1955) provided a brief account of *Diadoxus* noting that two species of the genus infest various cypress pines (*Callitris* and *Cupressus*) and that trees attacked first show symptoms of dying back and loss of colour. Occasionally, the adults have been found emerging through floor coverings in newly erected dwellings, the larvae having continued their development after the pine timber used floor flooring had been laid down; there is however, no reinfestation of the timber (ZECK, 1955). The account virtually follows that of FROGGATT (1923, 1925, 1927) and MCKEOWN (1942).

BRIMBLECOMBE (1956) briefly commented on the biology of *Diadoxus* and noted that attack of *Cupressus* spp. often occurred after four or more years after planting.

The next published reference to *Diadoxus* is in the article on wood borers by ANON. (1958) but the entry is exactly the same as ZECK (1955); hence no new data have been presented in this article.

HADLINGTON & GARDNER (1959) provided further observations on the biology of *D. erythrurus* based on studies undertaken in New South Wales, where severe forest fires had occurred in the Pilliga State Forest (near Baradine, c. 31° 00´ S, 149° 20´ E) during November 1951, and in the Euglo and Manna State Forests (near Forbes, c. 33° 15´ S, 148° 00´ E) during December 1957. HADLINGTON & GARDNER (1959) stated that *D. regius* Peterson (as *D. scalaris* Laporte & Gory), the larger species, also occurred in association with *D. erythrurus* and that its colouration and feeding habits were similar to those of *D. erythrurus*, but that during their investigations on fire-damaged cypress pines, *D. regius* was encountered only rarely, with most of the attack being due to the smaller species; after fires have occurred in the cypress pine areas of New South Wales, timber arriving in Sydney from the burnt forests some months later, consistently showed damage by *Diadoxus*. The time taken to complete the life-cycle was found to be variable, and was dependent on the time of the year when oviposition occurred; in summer, the period was as short as 3 months, while in the case of those insects which over-wintered as larvae or pupae, the period was extended to 10 months or more under unfavourable conditions (HADLINGTON & GARDNER, 1959). Observations made in the Baradine district on the overwintering generation indicated that adults emerge during September to October and that at least two generations are sometimes possible within one year; the adults are present from September to April, and larvae may be found beneath the bark of attacked trees at any time during the year; larvae have been observed in all

but the very early instars during June, July and August (HADLINGTON & GARDNER, 1959). Forest fires occurred in the Pilliga State Forest during 1951 and in the Euglo and Manna State Forests during 1957; *D. erythrurus* adults oviposited in the damaged bark of *Callitris glaucophylla* (as *C. hugelii*) when the fire was most intense, the cambium and phloem regions around the circumference of the tree were often completely destroyed, producing conditions which were unfavourable to the development of the larvae; in trees which were only slightly burnt and where the damage to the phloem and cambium was localised, the larvae were able to develop and encroach into the healthy tissue since the damage to the phloem and cambium was localised, while in trees which had been affected on one side only, larvae were able to develop on the edges of the damage; negligible infestation occurred in the branches and upper portions of the bole since these parts of the tree were unaffected by fire damage; in this way, fire produces favourable conditions within the tree for the development of *D. erythrurus* (HADLINGTON & GARDNER, 1959). *Callitris glaucophylla* (as *C. hugelii*) growing in Pennant Hills, a suburb of Sydney, has also been attacked by buprestid larvae following defoliation by the cypress pine sawfly, *Zenarge turneri* Rohwer (Hymenoptera) (HADLINGTON & GARDNER, 1959). To summarise the findings of HADLINGTON & GARDNER (1959): *D. erythrurus* usually requires an injury for the initiation of attack, but unless this injury is accompanied by other conditions such as damage to the crown of the tree or periods of low rainfall, the infestation does not necessarily progress; forest fires frequently damage the crowns of trees as well as injuring the bark, thus producing conditions favourable to the development of *D. erythrurus*; trees affected in this way are not only susceptible to attack, but are likely to be completely girdled by the buprestid larvae particularly if periods of low rainfall occur; when substantial rains occur after a fire, trees produce sandaric resin which is clear and sticky when fresh and the young larvae are not able to encroach the cells actively producing it; the introduced *Cupressus macrocarpa* var. *lambertiana* does not require to be injured before *D. erythrurus* can initiate an attack; parasites and predators were abundant immediately after the high rainfall was recorded, but later examinations showed that their numbers had fallen markedly, probably because the *D. erythrurus* larvae had been affected by the resin production; prior to the channels being invaded by the resin, these biotic factors had reduced the numbers of *D. erythrurus* considerably, and in their absence the progress of attack would have been accelerated; therefore, parasites and predators would have their greatest effect on the population of *D. erythrurus* during prolonged dry weather and before resin flowed into the channels; it is doubtful if drought alone causes major changes in the stand composition of cypress pine forests by predisposing *Callitris* spp. to attack by *Diadoxus*; the changes recorded by VON LENDENFELD (1885) may have occurred, but the more gradual effect of settlement on stand composition in these areas has not been investigated; there has been a tendency to produce tree-stands composed largely of cypress pines at the expense of the eucalypt species which grow naturally in association with them; this trend is more likely to accentuate attack by insects.

MOORE (1972) briefly noted that *Callitris glaucophylla* (as *C. hugelii*) was attacked by *Diadoxus* and noted that there was niche differentiation between the two species in regards to the positions of larval feeding in trees where larvae of both species occurred. MOORE (1972) writes: "On the present knowledge concerning the habits of the two [*Diadoxus*] species, it appears that larval populations of both species intermingle, and compete for existence at the overlapping extremes of their biological niches in the cambium-phloem region of either large, debilitated trees, or plants of regeneration under stress. However, larvae of *D. scalaris* generally utilise the lowest portion of a stem, and the root system, while larvae of *D. erythrurus* generally utilise the upper portion and limbs of a tree. In young regeneration, adults of either species have been found associated with the death of plants, but the workings of *D. scalaris* appear to extend into the root system whereas those of *D. erythrurus* appear to be confined to that portion of the stem occurring above ground-level."

PETERSON & HAWKESWOOD (1980) reviewed the then available data on the biology and distribution of *D. erythrurus* and *D. regius* (as *D. scalaris*) in Western Australia, and provided the first published field observations in that State on adult behaviour and potential adult/plant associations as well as the first map published showing the distribution of an Australian buprestid. PETERSON & HAWKESWOOD (1980) noted that adults of *D. erythrurus* had been observed on

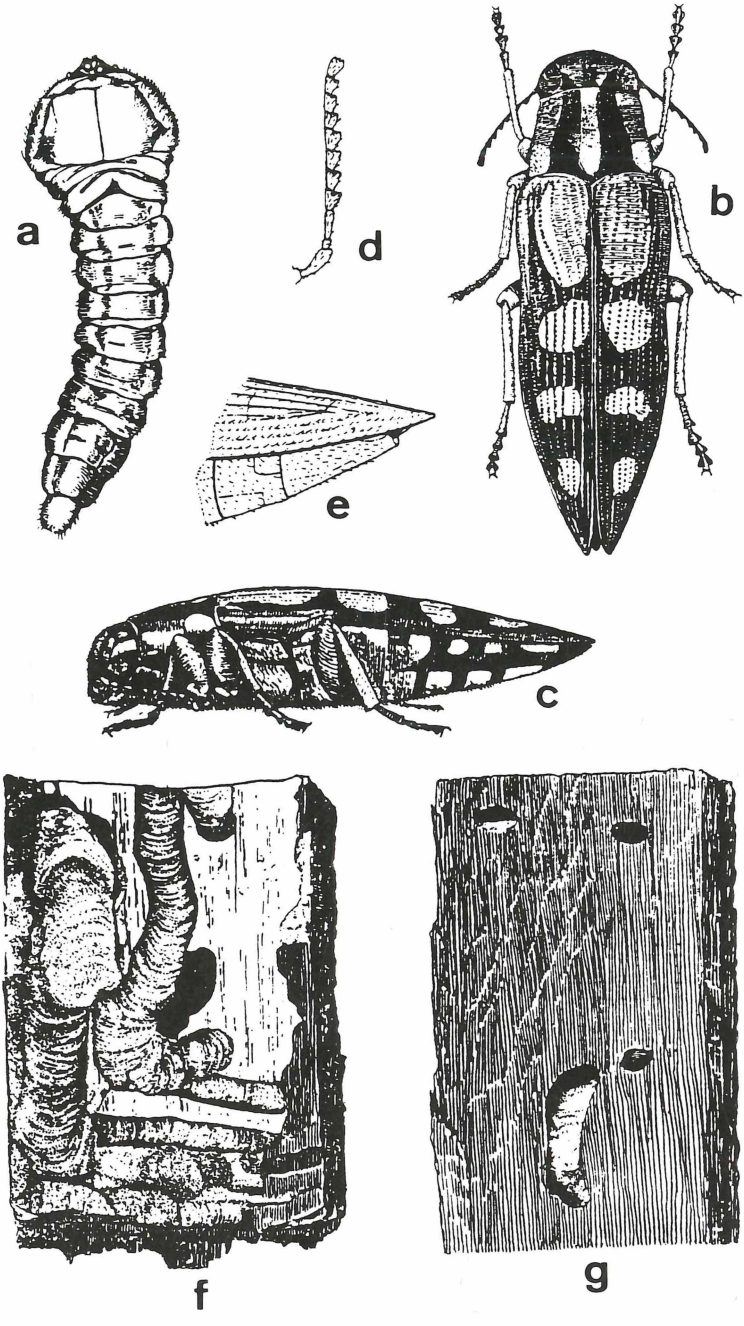

Fig. 2. *Diadoxus erythrurus* (White). a: Larva, [probably drawn from dried specimen, see comments in text of this paper and compare with Figure 1, this paper]; b: Adult, dorsal view; c: Adult, lateral view; d: Right antenna, dorsal view; e: Apex of abdomen of adult, lateral view; f: Section of wood of *Callitris* sp. (Cupressaceae), showing damage by *D. erythrurus*; g: Undersurface of bark showing damage by larvae. (Illustration from FROGGATT, 1927, plate IX, page 35)

Callitris preissii Miq. subsp. *verrucosa* (A. Cunn. ex Endl.) J. Gardner (cited as *Callitris verrucosa*) (Cupressaceae) near Wurarga, Western Australia (c. 28° 26´ S, 116° 06´´ E) (see also HAWKESWOOD, 1987 and Figure 3, this paper) and on an unidentified species of *Pinus* (Pinaceae) at Attadale, a Perth suburb. PETERSON & HAWKESWOOD (1980) remark that although feeding by the beetle on *C. preissii* was not observed, it is probable that it utilises this plant for food in the adult stage and that the collection of the species from Attadale possibly indicates that the species has been either introduced in pine timber (since native *Callitris* pines are rare in the Perth area) or breeds in native *Casuarina*; the species has probably established itself in species of *Pinus* or *Casuarina* in some suburbs of the Perth metropolitan area. Some important observations made by HAWKESWOOD & PETERSON (1980) for the first time for Australian Buprestidae include procrypsis exhibited by the adults of *Diadoxus*: adults are apparently afforded protection from predation by adopting a vertical resting position in the central region of *Callitris* trees and *Casuarina* bushes (see Figures 2 & 3 in PETERSON & HAWKESWOOD, 1980, plate 97 in HAWKESWOOD, 1987 and Figure 3, this paper); it is probable that *Casuarina* plants afford more protection since the alternation of yellow and green on the branchlets better fits the undersurface pattern of *Diadoxus*; in this way, the habit of the beetles frequenting *Casuarina* may result in lower incidence of predation on buprestid populations in areas where pines and *Casuarina* occur sympatrically, in comparison to that in areas where only *Callitris* occur; the most likely predators of *Diadoxus* are birds such as magpies and butcherbirds.

HAWKESWOOD (1980), in a general, popular article on the Australian Buprestidae, provided a brief review of *Diadoxus* biology and noted that occasionally these beetles have been found emerging through floor coverings in newly erected buildings and that an "outbreak" of *D. erythrurus* had occurred several years previously in a newly constructed building of one of the residential colleges at the University of New England, Armidale, New South Wales.

HAWKESWOOD & PETERSON (1982) provided a brief review of the biology and hosts of *D. erythrurus*, and recorded *Callitris glaucophylla* Thompson & Johnson (cited as *C. columellaris* F. Muell.) as a host and suggested that the plant association with primitive, arid-adapted conifers (Gymnospermae) indicated that *Diadoxus* may have evolved during the time when Central Australia was drying out after the Gondwanaland breakup. The utilisation of *Callitris* and *Cupressus* was considered by HAWKESWOOD & PETERSON (1982) to be a very ancient association and probably co-evolutionary, without any food-plant shifts to or from other unrelated plant taxa.

Fig. 3. *Diadoxus erythrurus* (White): adult in typical resting position on the foliage of its larval host plant, *Callitris preissii* subsp. *verrucosa* (Cupressaceae) in the Wurarga district of Western Australia. (Photograph: D. G. Knowles, from HAWKESWOOD, 1987)

HAWKESWOOD (1985) provided a detailed description of the larva of *D. erythrurus* (see also Figure 1, this paper) and recorded the larval host as *Callitris glaucophylla* Thompson & Johnson (cited as *C. columellaris* F. Muell.). It was hoped that morphology of the *Diadoxus* larva may have shed more light on the taxonomic placement and phylogeny of the genus (HAWKESWOOD, 1985), but unfortunately, larvae of purported related genera (i.e. *Cyria, Cyrioxus, Epistomentis* etc.) have not been described, so comparisons are unable to be made at this stage. *Diadoxus* presently remains in the tribe Epistomentini of the subfamily Chalcophorinae (LEVEY, 1978; BELLAMY, 1986).

HAWKESWOOD (1987) provided a short summary on the biology and host-plants of *D. erythrurus* and provided the first colour photograph of an adult beetle in its natural habitat on its larval host plant, *Callitris preissii* Miq. subsp. *verrucosa* (cited as *C. verrucosa*) (see also figure 3, this paper).

(b) Parasites

The incidence of parasitism on *D. erythrurus* has been studied in June 1952, by HADLINGTON & GARDNER (1959), after the 1951 bushfires in the Pilliga National Forest, New South Wales. These studies were confined to observations and rearing of larvae; most of the parasites were obtained by removing sections of the bark and collecting the larvae and pupae of the parasites; the effect of these parasites was reflected in the small number of *D. erythrurus* larvae actively feeding at the time of observations (HADLINGTON & GARDNER, 1959). The parasites are as follows: (a) *Doryctes diadoxi* Nixon (Hymenoptera: Braconidae) – this was the most abundant species and occurred singly during the early instars, but pupated in cocoons each of which contained 6–8 larvae; the cocoons were located in the channels of *D. erythrurus* larvae; this parasite was originally described from *Diadoxus* (NIXON, 1954) and is regarded as ectophagous; (b) *Polymoria* sp. (Hymenoptera: Eupelmidae) – the larvae of this parasite occurred singly in the various instars; they are probably ectophagous and either parasitic or hyperparasitic on *Diadoxus* larvae; (c) *Metapelma* sp. (Hymenoptera: Eupelmidae) – this species occurred in association with *Polymoria* sp.; (d) *Megalyra* spp. (Hymenoptera: Megalyridae) – these larvae occurred singly in the channels of *D. erythrurus*; (e) *Thaumasura* sp. (Hymenoptera: Cleonymidae) – the larvae of this species occurred singly in the channels of *D. erythrurus*; (f) *Pristaulacus* sp. (Hymenoptera: Evaniidae) – this species was collected on the surface of the bark of *C. huegelii* and is therefore a potential parasite; (g) Cleridae – larvae of this family were found to be active in the channels.

(c) Summary of larval host plants and references

Callitris endlicheri (Parlatore) F. M. Bail. (Cupressaceae): HADLINGTON & GARDNER (1959), HAWKESWOOD (1987).

Callitris glaucophylla Thompson & Johnson [formerly *C. columellaris* F. Muell. in part, *C. macrocarpa* R.Br. and varieties, and *C. huegelii* (Carr.) Franco] (Cupressaceae): FRENCH (1911), GOUDIE (1920), PESCOTT (1932), HADLINGTON & GARDNER (1959), MOORE (1972), HAWKESWOOD & PETERSON (1982), HAWKESWOOD (1985, 1987)

Callitris preissii Miq. subsp. *verrucosa* (A. Cunn. ex Endl.) J. Gardner (formerly *C. verrucosa* A. Cunn. ex Endl.) (Cupressaceae): TEPPER (1887).

Callitris spp. (Cupressaceae): VON LENDENFELD (1885), FROGGATT (1907), MCKEOWN (1942), ZECK (1955), BRIMBLECOMBE (1956), ANON. (1958), HAWKESWOOD (1980).

Cupressus macrocarpa Hartweg var. *lambertiana* Gordon (Cupressaceae): FRENCH (1911), FROGGATT (1923, 1925, 1927), PESCOTT (1932), MCKEOWN (1942), HADLINGTON & GARDNER (1959), HAWKESWOOD (1987).

Cupressus spp. (Cupressaceae): ZECK (1955), BRIMBLECOMBE (1956), ANON. (1958), HAWKESWOOD (1980).

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