

## NOTES ON THE BIOLOGY OF THE GENUS *PLETHOLAX* COPE (SQUAMATA: PYGOPODIDAE)

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### ABSTRACT

*Pletholax* is a monotypic genus of pygopods, with two subspecies recognised. The nominate subspecies is an inhabitant of heaths and woodlands, particularly *Banksia*-dominated associations, on sandy substrates, while *P. gracilis edelensis* inhabits heaths and tussock grasslands on sandy substrates. *Pletholax* is active both above and below the soil surface. Size at maturity, sexual dimorphism in adult size and adult sex ratio are documented. The gonadal cycles of both sexes peak in Spring. Clutch size is two. Diet remains unknown, but the species may feed predominantly on termites. Predation by birds is reported. Neither subspecies appears to be endangered.

### INTRODUCTION

*Pletholax* Cope is a monotypic genus of pygopodid lizard restricted to the lower/mid west coasts of Western Australia. Morphologically, it is one of the most divergent of the pygopodids, with an extremely slender elongate body, a depressed pointed head and strongly bicarinate scales on all surfaces (dorsal, lateral, ventral) of body and tail. Internally, it is unique amongst pygopodids in possessing an interclavicle (Stephenson 1962), although the homology of this element remains contentious (Kluge 1976).

Although several authors have commented on habitat preferences and other aspects of the biology of *Pletholax* (Mertens 1965; Kluge 1974; Storr and Harold 1978; Davidge 1979, 1980; Wilson and Knowles 1988; Greer 1989; How and Dell 1990; Storr *et al.* 1990; Turpin 1990, 1991; Ehmman 1992; Maryan 1993), much of this literature is in the form of broad unsubstantiated statements, or of very limited circulation. There are few specific details published on the ecology of this genus. Accordingly, we take this opportunity to review the literature and provide additional data on the ecology of *Pletholax*, based on the dissection of museum specimens ( $n = 66$ ), field and captive observations, and collection data associated with museum material.

### HABITAT PREFERENCES

Two subspecies of *Pletholax* are recognised: *P. g. gracilis* Cope from predominantly coastal areas between Geraldton and the Perth region, and *P. g. edelensis* Storr from the Kaibbarri-Shark Bay region (Storr 1978; Storr *et al.* 1990). The nominate subspecies has been reported from *Banksia/Eucalyptus* woodlands or heaths on sandy soils (Kluge 1974; Davidge 1979, 1980;

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Wilson and Knowles 1988; How and Dell 1990; Storr *et al.* 1990; Turpin 1990; Ehmann 1992; Maryan 1993). Kluge (1974) trapped six specimens from a mixed *Banksia/Eucalyptus* coastal woodland community on stationary dunes and protruding limestone ridges, but on the basis of specimens recorded from Red Hill and Coomberdale, inferred that the taxon was not restricted to such habitats. Wilson and Knowles (1988) state that this subspecies occasionally occurs on lateritic soils. Specific habitat data are available for museum specimens from six localities: Koondoola, Mooliabeenee, Murdoch, North Lake, Victoria Park and Willetton. In all cases the habitat consisted of *Banksia* dominated woodland or heath on sand (white or grey when specifically noted). The Jandakot series was also taken from *Banksia* woodland on deep sands (Davidge 1979, 1980). An additional specimen, from 30km WSW of Badgingarra, was reported from mid-high heath. Although specific habitat data are unavailable for all other specimens (see "Material Examined"), we are aware of sandy substrates (often with *Banksia* communities) in the vicinity of all localities, with the possible exception of 13km WSW Winchester, which we have not visited. At Karawara (originally Manning/South Perth, 32°00'S 115°51'E) one of us (MP) observed and collected *Pletholax* in a *Banksia* woodland over heath understory on white siliceous Bassendean sands with *Banksia menziesii* R.Br. (dominant), *B. attenuata* R.Br. and *B. ilicifolia* R.Br., *Eucalyptus todtiana* F.Muell., *Allocasuarina fraseriana* (Miq.)L.Johnson, *Pattersonia occidentalis* R.Br., *Daviesia triflora* M.D. Crisp and *Stirlingia* sp. In contrast, a single specimen was found at Green Head (30°04'S 114°58'E) in low coastal heath (lacking *Banksia* spp.) on white calcareous sand.

*Pletholax g. edelensis* is also known from sandy substrates (Storr and Harold 1978; see also Wilson and Knowles 1988; Storr *et al.* 1990), although *Banksias* are not present. Instead, specimens have been taken from *Spinifex longifolius* R.Br. on coastal dunes, low open *Triodia plurinervata* N. Burb. under low *Acacia* on light pink-brown sandy loam and very sparse *Acacia* shrubs over dense low heath on grey loamy sand (MP *pers. obs.*; data accompanying type series and WAM R103978, R104259-60).

## HABITS

The earliest published observations on the habits of *Pletholax* (Kluge 1974:38,148) noted that six individuals of *P. g. gracilis* held in captivity habitually burrowed into sand, and described the species as "an extremely rapid sand swimmer". Kluge (*in Gans* 1975) similarly describes the species as a sand swimmer. In contrast, Bamford (*in Greer* 1989) observed individuals leaping between shrubs to escape capture, and Wilson and Knowles (1988) and Ehmann (1992) respectively suggest that the species is occasionally/mostly active above ground, gliding through dense vegetation, and basking in shrubs. Davidge (1979), although lacking specific field observations (all her material was pit-trapped) suggested that the species was arboreal, on the basis of the keeled scales, "cautious movements .... [when] .... hooked over a slippery rod" (Davidge 1979:65), prehensile tail and "stick-like rigidity" (Davidge 1979:95). She reported that "the body and most of the tail of *Pletholax* were held rigid so that individuals curled the tip of the tail around a finger when held but rarely curled the whole body" (Davidge 1979:54). However, such behaviour could also be explained as an adaptation to pushing through dense low vegetation such as tussock grasses, through the meshwork formed in leaf litter mats, or to facilitate fossorial activity.

It is clear from the collection of many specimens in pit-trap lines (Mertens 1965; Kluge 1974; Davidge 1979, 1980; Turpin 1990, 1991; Maryan 1993; data accompanying WAM R42955, R78091, R83188, R89379, R94496, R94649) that *P. g. gracilis* is often active on the surface. However, Kluge's observations of fossorial activity are supported by the collection of one specimen

in a dead rotting stump (Wilson and Knowles 1988; data accompanying WAM R85383) and our observations (MP). One individual captured at Karawara was placed overnight in a bucket with approximately 16cm of sand. When the bucket was examined the following morning, the lizard had burrowed to the very bottom of the sand layer. The depth to which the lizard had burrowed in loose sand suggests that fossoriality is more than simply occasional, although the extent of subsurface activity remains to be determined.

### BODY SIZES

Davidge (1979, 1980) reported a minimum mature SVL of 60mm for *P. g. gracilis* and did not identify any sexual dimorphism in adult size. A gravid female with SVL 75mm was reported by Mertens (1965). Our data indicate that, as for other pygopodids for which data are available (Kluge 1974; Patchell and Shine 1986; Webb and Shine, in press), female *Pletholax* of both subspecies are larger than males. Mature female *P. g. gracilis* had SVL 67.5-83.0mm ( $\bar{x} = 75.2$ ,  $sd = 4.07$ ,  $n = 22$ ), while mature males were significantly smaller, with SVL 56-69.5mm ( $\bar{x} = 62.4$ ,  $sd = 3.09$ ,  $n = 30$ ; Mann-Whitney U test,  $z = 6.075$ ,  $p < 0.001$ ). For *P. g. edelensis*, which attains greater sizes, the direction of the sexual dimorphism was the same (mature females: SVL 79.0-88.0mm,  $\bar{x} = 83.0$ ,  $sd = 3.81$ ,  $n = 4$ ; mature males: SVL 67.5-80.0mm,  $\bar{x} = 72.6$ ,  $sd = 5.65$ ,  $n = 4$ ; Mann-Whitney U test,  $U = 1$ ,  $p < 0.05$ ). Minimum mature size was determined by the presence of yolking ovarian follicles in females, and enlarged turgid testes accompanied by opaque deferent ducts in males.

Of 66 individuals, representing both subspecies, only four were immature: one subadult female (WAM R80937; SVL = 67.5mm) and three very small unsexed juveniles (WAM R62577-78, R85383; SVL range 29.0-36.5mm), the latter collected in February and March. A similar paucity of juveniles (2 of 25 captures) was reported by Davidge (1979).

### SEX RATIO

Davidge (1980) reported a significant excess of adult males in the material she examined (17 adult males:6 adult females), although she did not provide any analysis of seasonal variation in sex ratio. From the material examined here, there was some evidence for seasonal variation in adult sex ratio. In *P. g. gracilis*, adult females outnumbered adult males in the cooler months (March-August; 7:2) while the reverse was true in Spring (September-November; 10:15) and Summer (December-February; 5:11). Pooling Spring and Summer samples, these differences are almost statistically significant ( $\chi^2 = 3.43$ , 1 d.f.,  $0.10 < p < 0.05$ ). Davidge's sample was mostly collected between September and January, with fewer than two captures in each of March, April and May, and no captures in other months over a 16 month period (Davidge 1979).

### REPRODUCTIVE CYCLE

#### Male

Davidge (1979, 1980) reported an October peak in testis size in *P. g. gracilis*, with reduced testes in January. In the material we examined, mature-sized males of this subspecies collected in December/January ( $n = 12$ ) and March ( $n = 1$ ) had small flattened testes and transparent deferent ducts. A single male collected in May had moderately enlarged testes but transparent deferent ducts. September ( $n = 3$ ) and October ( $n = 9$ ) males had enlarged turgid testes and opaque deferent

ducts. Of three males collected in November, one had enlarged turgid testes and opaque ducts while the others were similar to December males. Males of *P. g. edelensis* were only available for August/September (n = 3) and January (n = 1). The former specimens had enlarged testes while the latter had small testes. These data are consistent with a Spring peak in the male cycle in both subspecies.

The only other published data on the timing of the male reproductive cycle in pygopodids are for populations of *Delma fraseri* and *Pygopus lepidopodus* sympatric with *P. gracilis* (Davidge 1979, 1980), and for *Lialis burtonis* (Saint Girons *et al.* 1992). All three taxa similarly show a Spring/early Summer peak in testis size and spermiogenesis, although later in the season than in *Pletholax* (November in *Pygopus* and possibly *Lialis*, December in *Delma*). A Spring peak in testis size has also been reported in other southern Australian gekkonoids (How and Kitchener 1983; How *et al.* 1986).

### Female

Davidge (1979, 1980) reported an October peak in "egg" size for *P. g. gracilis*, although she did not indicate whether this referred to ovarian follicles or oviducal eggs. Ehmann (1992) similarly reports oviposition in October (subspecies not identified) while Mertens (1965) reports an ovigerous *P. g. gracilis* collected 15 November. Of our material, mature-sized females of *P. g. gracilis* collected in March (n = 5), April (n = 1) and July (n = 1) showed no follicular activity. A single September female (11 September) had slightly enlarged follicles beginning to develop yolk. Of six October females, one (collected 2 October) showed no follicular activity, three (one from 23 October, others without precise date) had enlarged yolking follicles (6.3-9.3mm long), one (31 October) carried shelled oviducal eggs and one (no precise date), although showing little follicular activity, had grossly dilated oviducts suggesting recent oviposition. Of three November specimens, one (22 November) carried shelled oviducal eggs, while the others showed no follicular activity. Of five specimens collected December/January, one (19 December) carried shelled oviducal eggs, while the remainder were reproductively inactive.

Only four female *P. g. edelensis*, all collected in August, were examined and all lacked follicular development.

The pattern of Spring vitellogenesis and oviposition in *Pletholax* is consistent with data on other pygopodids (Davidge 1979, 1980; Patchell and Shine 1986).

### CLUTCH SIZE AND EGG SHAPE

In all cases, *Pletholax* clutch size was two, one in each ovary/oviduct (n = 3 with enlarged ovarian follicles; n = 3 with oviducal eggs). A clutch size of two has also been reported for *Pletholax* by Mertens (1965), Davidge (1979, 1980), Bamford (*in Greer* 1989) and Ehmann (1992), and for other pygopodids by Patchell and Shine (1986).

Both enlarged yolking follicles and shelled oviducal eggs were extremely elongate, with straight sides and rounded ends. Davidge (1979, 1980) reports maximum egg dimensions of 13 x 4mm, while Mertens (1965) reports two eggs of 16-17 x 5mm. The elongate egg shape probably reflects anatomical constraints imposed by the slender body.

### DIET

Almost nothing has previously been reported on the diet of *P. gracilis*. Davidge (1979:96), although finding no identifiable material in the stomachs of her material, observed captives readily

lapping honey/water mixtures, and, combined with her assumption of arboreality for the species, suggested that the species may feed primarily on nectar or pollen of *Banksias*. However, she was unable to obtain support for this view by direct evidence, with no identifiable pollen in stomach content smears, and a lack of interest by captive *Pletholax* in freshly picked *Banksia* inflorescences. Greer (1989), quoting Ehmann (*pers. comm.*), states that captive *Pletholax* were "seen to lick sweet fruit (apple and banana) and to lap honey water". Ehmann (1992) states that *Pletholax* "licks nectar from heath flowers, and the body fluids of small, soft insects and spiders that abound near the flowers. The spiders are grasped by the body, the abdomen is broken, and the juices are licked up".

Stomach contents were lacking from most preserved specimens we examined (unfortunately the stomachs had previously been removed from most of the large Jandakot series, which comprises about half the available specimens), while the colon mostly contained only small amounts of indeterminate faecal material. The stomach of one specimen (WAM R23918) contained approximately 60 short segments of vegetable matter (2-2.5x0.5mm) with striate surface, with a similar number in the colon. The colon of a second specimen (WAM R61907) contained an insect head-capsule (1.5x1.6mm), possibly of a termite worker. A small section of tough, smooth arthropod chitin, possibly part of another insect head-capsule, was found in AM R13815.

While these data are insufficient to definitively identify the dietary preferences of *Pletholax*, several comments are possible. Firstly, the paucity of digesta in the gut of *Pletholax* contrasts markedly with most other pygopodids. Patchell and Shine (1986) reported stomach contents from 47-89% of *Lialis*, *Pygopus* and *Delma* species they examined, while we have observed large amounts of chitinous arthropod remains in the stomach and/or colon of the majority of specimens of *Delma* and *Aclys* that we examined. The myrmecophagous *Aprasia*, on the other hand, resemble *Pletholax* in the paucity of food items across samples (Webb and Shine, in press). The lack of food in *Aprasia* has been attributed to infrequent "binge-feeding" in local food-rich microenvironments (ant nests) (Webb and Shine, in press).

Secondly, the short segments of vegetable matter present in one *Pletholax* specimen appeared to be fine stem segments (possibly grass) rather than floral elements. Further, their even length suggests cropping by insect mandibles, rather than the masticating teeth of *Pletholax* (Rieppel 1984; M. Hutchinson, *pers. comm.*). The combination of these data, with the possible identification of isopteran material, leads us to tentatively suggest that *Pletholax* may feed predominantly on termites. This suggestion is consistent with the general absence of identifiable gut contents in the specimens examined, which were mostly pit-trapped or surface collected in other ways (hence away from feeding sites), and with the collection of a single individual in a dead stump. The plant material may have been secondarily or accidentally ingested within or near a termite colony.

Finally, we note that although nectivory could also explain the lack of gut contents in the specimens, there is a paucity of near-ground-level nectar-bearing plants at several of the known localities for *P. g. edelensis*. This observation is inconsistent with the conclusions presented by Ehmann (1992), although we do not exclude the possibility that occasional nectivory could occur.

## PREDATION

One specimen (WAM R12687; collected 19 December) was noted as being "caught by Kestrel [*Falco cenchroides*] nesting in cave". Two specimens (AM R13815, R26628; collected 11 September) were taken from the stomach of a magpie (*Cracticus tibicen dorsalis*). In both cases it is probable that the lizards were taken when active on the surface.

## CONSERVATION STATUS

It has been suggested that *Pletholax* may be at risk due to land clearing within its range (Ehmann 1992). Certainly, original native vegetation is now rare or absent at many of the localities in the Perth metropolitan area from which the species was formerly collected, and there would appear to have been a reduction in distribution in this region. However, the nominate subspecies is known from a number of reserves, and has an extensive distribution outside the Perth region, while the known localities for *P. g. edelensis* remain little disturbed, with the southernmost occurring within Kalbarri National Park.

## MATERIAL EXAMINED

### *P. g. gracilis*

**Australian Museum (AM):** R13815, R26628, Mandurah (32°32'S 115°43'E)

**Western Australian Museum (WAM):** R4212, R104374, Victoria Park (31°59'S 115°53'E); R9697, Coomberdale (30°27'S 116°02'E); R11150, South Perth (31°59'S 115°51'E); R13682, R23918, Dianella (31°54'S 115°53'E); R16886, Red Hill (31°23'S 116°06'E); R12687, Jurien Bay (30°15'S 115°01'E); R25071, Eneabba (29°49'S 115°16'E); R36172, Bentley (32°01'S 115°55'E); R42955, Sorrento (31°48'S 115°44'E); R60017, 30km WSW Badgingarra (30°28'S 115°12'E); R61895-98, R61900, R61902-03, R61905-11, R62577-81, R64723-25, Jandakot (32°06'S 115°53'E); R60940, 13km WSW Winchester (29°49'S 115°49'E); R78091, R82912, R93004, Mooliabeenee (31°20'S 116°01'E); R80932, R80934-38, R83188, Murdoch (32°04'S 115°49'E); R82856, Wireless Hill (32°01'S 115°49'E); R85383, Koondoola (31°50'S 115°51'E); R88063, Cottesloe (31°59'S 115°45'E); R89379, R96195, Willetton (32°02'S 115°52'E); R94496, North Lake (32°04'S 115°49'E); R94649, Boonanarring Nature Reserve (31°13'S 115°50'E); R97606, Perth airport (31°56'S 115°58'E); R106108, R106171-72, Marangaroo (31°50'S 115°51'E)

### *P. g. edelensis*

**WAM:** R54755, 5km S Useless Loop (26°10'S 114°24'E); R54814, R54863, 4km S Useless Loop (26°10'S 114°24'E); R55085, 10km NW Useless Loop (26°05'S 113°19'E); R97304, 13km E Kalbarri (27°41'S 114°17'E); R103978, Edel Land (26°17'S 113°19'E); R104259-60, Edel Land (26°16'S 113°16'E)

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