role of producing diploid offspring.

It remains to be seen if this social system is usual in this species, how other aspects of social behaviour are affected, and whether colonies normally have only one mated queen. *P. modesta*, a close relative of *P. arnoldi* (Villet, Hart & Crewe 1990b), also has a queen caste, but it is not known how similar the reproductive biologies of the two species are.

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The taxonomic status of *Apogon enigmaticus* Smith, 1961 (Teleostei, Apogonidae)

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The validity of the cardinal fish species *Apogon enigmaticus*, described by Smith (1961) from a single specimen, is reassessed in view of a recent discovery of a second specimen of this species, collected by Smith, in the J.L.B. Smith Institute of Ichthyology. Both fish were re-identified as specimens of *A. apogonides* (Bleeker, 1856) on the basis of dentition, pigmentation, and counts of pectoral-fin rays, gill rakers and predorsal scales. *A. enigmaticas* is therefore regarded as a junior synonym of *A. apogonides*.

Die geldigheid van die kardinaalvisspesie *Apogon enigmaticus*, wat deur Smith (1961) van 'n enkele eksemplaar beskryf was, word heroorweeg in die lig van 'n onlangse ontdekking van 'n ander eksemplaar van hierdie spesie, versamel deur Smith, in die J.L.B. Smith Instituut van Viskunde. Albei visse is herbeskryf as eksemplare van *A. apogonides* (Bleeker, 1856) op die basis van die tande, kleur (pigmentasie) en hoeveelheid van pektoraalvinstrale, kieuharke, en predorsale skubbe. *Apogon enigmaticus* word dus beskou as 'n junior sinoniem van *A. apogonides*.

The cardinal fish species *Apogon enigmaticus* was described by Smith (1961) from a single poorly preserved specimen collected in Durban. In his original description Smith (1961) expressed reservations about the validity of this species, but decided to name it 'chiefly for purposes of record in case further specimens come to light.'

The holotype of *A. enigmaticus*, lodged in the South African Museum, Cape Town (SAM), was originally identified as *A. monochrous* (Barnard 1927). The latter name was also used for two other specimens from Durban described by Regan (1916). These two specimens were re-identified as *A. apogonides* (Bleeker, 1856), apparently by J.L.B. Smith himself.

Recently, the author discovered another specimen labelled *Apogon enigmaticus* in the collection of the J.L.B. Smith Institute of Ichthyology, Grahamstown (RUSI). This fish was collected, and presumably identified, by J.L.B. and M.M. Smith, in Transkei, 1948. An examination of this fish revealed that it is a specimen of *A. apogonides*. This finding prompted the author to re-examine the holotype of *A. enigmaticus* and compare both fishes with specimens of *A. apogonides* in order to reassess the validity of the former species.

Material and Methods

Apogon enigmaticus: SAM 13817, 77,2 mm SL, holotype, South Africa, Durban, collected by H.W. Bell Marley, 1915; RUSI 20565, 72,4 mm SL, South Africa, Transkei, Xora, collected by J.L.B. and M.M. Smith, 1948.

Apogon apogonides (comparative material): RUSI 1429, 88,0 mm SL, Reunion Island; RUSI 3094, 58,0 mm SL,

Seychelles, Mahé; RUSI 3096, 67,7 mm SL, Seychelles, Providence Island; RUSI 3099, 42,6 mm SL, Kenya, Malindi; RUSI 3100, 61,4 mm SL, Mozambique, Ibo Island; RUSI 3845, 2: 41,7–64,4 mm SL, Mozambiqae, Quirimba Island; RUSI 9181, 13(of 57): 42,8–86,7 mm SL, South Africa, Natal, Sodwana Bay; RUSI 15925, 104,4 mm SL, South Africa, Darban; RUSI 18334, 67,4 mm SL, Mauritius, NE of Grand Baie; RUSI 19208, 3: 39,0–51,5 mm SL, South Africa, Natal, Leadsman Shoal; RUSI 35467, 5: 73,9–82,1 mm SL, Grande Comore Island.

Pectoral fin rays were counted on both sides of the fish and include the uppermost rudimentary ray. Counts of total gill rakers include all radiments. A developed gill raker has a free-moving tip, and its length is equal to the width of its base or longer.

Results and Discussion

The holotype and the second specimen of *A. enigmaticus* were compared with 30 specimens of *A. apogonides* from several localities in the Western Indian Ocean. The counts of pectoral-fin rays, gill rakers and predorsal scales are presented in Table 1. Smith's (1961) counts of the holotype of *A. enigmaticus* were: 15 pectoral-fin rays; 6+15 (3+12 developed) gill rakers, presumably counted on the first gill arch of the left side; and 3–4 predorsal scales. My gill-raker count of the holotype was done on the first gill arch of the right side as this arch of the left side is damaged, and the gill rakers of the hypobranchial section are missing.

As a result of this comparison, I have no doubt that the holotype of *A. enigmaticus* is a specimen of *A. apogonides*., though a somewhat unusual one. As indicated by Smith (1961) the holotype is in a very poor condition; in fact, it is disintegrating. The fins are mostly missing and the head is badly damaged, especially on the left side.

Smith (1961) described the dentition of his specimen as 'Villiform teeth in bands in each jaw, some on side of lower jaw slightly enlarged...', a general, inadequate description. Although the jaws are damaged and nearly all the teeth are broken or uprooted, the pattern of the teeth in both jaws agrees with that of *A. apogonides*. The upper jaw has a wide band of minute teeth posteriorly, becoming progressively narrower anteriorly and tapering to about 3–4 series near the jaw symphysis. Judging from the stumps and tooth sockets on the anterior half of the jaw, the teeth of this section were significantly larger than those of the posterior half of the jaw, an arrangement characteristic of *A. apogonides*. The posterior part of the lower jaw has two compact series of teeth which become more laterally spaced anteriorly. The tooth stumps and the few entire teeth still present on the lower jaw indicate that the teeth of this jaw were caniniform rather than villiform, with those of the inner series largest. These characters of the lower jaw dentition are also typical of *A. apogonides*. The holotype of *A. enigmaticus* is unusual in that the upper jaw tooth band does not taper anteriorly as much as in the comparative specimens of *A. apogonides* which have usually two and rarely three series near the upper jaw symphysis. While the number of tooth rows may be size-dependent or subject to individual variation, the type of teeth and their pattern in the jaw (i.e. caniniform teeth anteriorly and villiform teeth posteriorly) is a species-dependent character.

Table 1 Frequency distribution of counts of pectoral-fin rays, gill rakers and predorsal scales in *Apogon apogonides* (*n* = 30) and *A. enigmaticus* (* = holotype)

	Pectoral rays		Gill rakers: developed			Gill rakers: total				Predorsal scales	
Species	13	14	16	17	18	19	20	21	22	4	5
apogonides	1	29	15	12	3	2	15	11	2	12	18
enigmaticus		2*	1*	1					2*	1	1*

In the comparative material the size of the teeth on the anterior half of the upper jaw varied and was not related to body length. In some fishes the teeth near the symphysis of this jaw were as large as those of the rear part of the lower jaw (usually the largest of all teeth). Others had only smaller teeth, in some cases only slightly enlarged. But in all the fishes these were caniniform teeth, distinctly different from the villiform teeth of the posterior part of the jaw. In the lower jaw of most fishes of the comparative material, the inner series teeth near the symphysis and those of the posterior part of the jaw were of similar size and were separated by a section of smaller teeth immediately behind the symphyseal ones. However, in several specimens all the teeth in the lower jaw were of similar size.

Smith's (1961) description of the preopercular edge as '...serrate, finely above, more coarsely about angle and below, small part in front entire' also agrees with most fishes of the comparative material. The second specimen of *A. enigmaticus* is unusual in that the entire vertical part of the preopercular edge, except a small area at the very top, is smooth. Variation with regard to the serration of the preopercular edge was observed in the comparative material. In several specimens the serrae were minute or absent altogether from the dorsal half of the vertical part of the bone. In one fish a smooth area occurred in the middle of the vertical part. Variation was also observed in the extent of serration along the ventral part of the preopercular edge.

One character mentioned by and which probably misled Smith (1961) was the dark rear edge of the scales which formed a 'network' on the body. A note on the museum label in the holotype's jar reads: 'Stained in preserving fluid before arrival at museum'. There is no telling whether Smith was aware of this, as it is not referred to in his description of and comments on the specimen. The collector of this fish, H.W. Bell Marley, used to stain fishes that were displayed in the Natal Museum, Pietermaritzburg. In the early 1980s a large collection of Bell Marley fishes which were on display in this museum were donated to the J.L.B. Smith Institute of Ichthyology, and all were found to be stained. A close examination of the holotype revealed that some scales remained unstained and had nothing to indicate the presence of natural pigment at their edges, certainly not as intense as the stained ones. In the comparative material, generally the body above the lateral line is more densely spotted and hence somewhat darker. In a fair number of fishes, regardless of size, the scale pockets of this part of the body, as well as those of the predorsal scales, have a distinctly darker edge. In most of

these the edge was dusky but in several it was dark brown. If Bell Marley's staining represents the pigmentation of the live holotype, then he collected an unusually dark specimen. It is more likely, however, that a mistake had been made and the wrong fish was stained. One species that typically has dark-edged scales and the 'network' pattern described by Smith (1961) is *Apogon kallopterus* (Gon 1986: pl. 51, fig. 175.2), a common resident of Natal reefs.

It is not clear to me why Smith (1961) did not include the second specimen, which was collected in 1948, in his description of *Apogon enigmaticus*. It is possible that this specimen was identified as the latter species after the original description had already been published, but there is no record of the original identification of the fish. In view of Smith's (1961) reasoning for naming *A. enigmaticus* (see introduction above) and his prolific scientific writing, it is rather unusual that he did not report the finding of the second specimen. This specimen is undoubtedly *A. apogonides*. It is in relatively good condition and has the same colour features of recently collected and preserved *A. apogonides*, i.e. a darkish stripe from the the tip of the snout to the eye with some traces on the opercle, a dark tip of the first dorsal fin and a dark intestine. Since it has no dark-edged scale pockets and its dentition is typical of *A. apogonides*, I can only assume that the relatively high total gill-raker count (Table 1) caused Smith to call it *A. enigmaticus*. In the Apogonidae, however, the number of developed gill rakers and their distribution on the first gill arch is a more distinctive character. Within a species, it is less variable than the total number of gill rakers (Table 1) and often provides better resolution in separating closely related species (unpublished data). In the present case, the number of developed gill rakers clearly relates both specimens of *A. enigmaticus* to *A. apogonides* (Table 1).

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Speculations on colonizing success of the African clawed frog, *Xenopus laevis* (Pipidae), in California

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The African clawed frog has been established in California for over twenty years. During that period, populations have spread to most of the drainage systems in southern California. It is suggested that a suite of contributing factors, including morphological, behavioural, and biochemical predator avoidance strategies, and reproductive and feeding (cannibalism) strategies, have aided in the success of this species in an extralimital situation.

Die gewone platanna is reeds langer as twintig jaar in Kalifornië gevestig. Gedurende hierdie tydperk het bevolkings versprei na meeste van die dreineringsstelsels in suidelike Kalifornië. Daar word voorgestel dat 'n reeks faktore, wat roofdierontwykingsstrategieë in terme van morfologie, gedrag en biochemie, sowel as voortplantings- en voedingstrategieë (kannibalisme) insluit, bygedra het tot die sukses van hierdie spesie in 'n ekstralimitale situasie.

The African clawed frog *Xenopus laevis* has been reported as an alien species in many areas of the United States, the United Kingdom, and Ascension Island (McCoid & Fritts 1980a). In the United States, established populations are known from Virginia, Arizona (R. Tinsley, pers. comm.), and California. *Xenopus laevis* was first reported as an exotic species in California over twenty years ago (St Amant & Hoover 1969). Since that time, few studies bave been published regarding the natural history of feral California populations (St Amant, Hoover & Stewart 1973; McCoid & Fritts 1980a; b; 1989; McCoid 1985) and none on other U.S. populations.

Naturally occurring permanent bodies of water in southern California are rare and all populations occur in situations that have been impounded or channelized, creating permanent to semi-permanent bodies of water where none had existed historically. The common factor in all established populations in southern California is the use of highly disturbed habitats. We examined populations of *X. laevis* in drainages of the Santa Margarita, Sweetwater, and Tijuana Rivers.

In California, *X. laevis* form dense populations (McCoid & Fritts 1980b). A contributing factor to the species' success in California appears to be reproductive strategies. Breeding in *X. laevis* is opportunistic and ovulation asynchronous (Dumont 1972; Fortune 1975) allowing reproduction to occur over most of the year in southern California (McCoid & Fritts 1989). While eggs and larvae are most commonly found between February and June (a period of