

TABLE I

The numbers of birds mist-netted in the Treen Brook Forest, near Pemberton, south-western Australia, on 31 net-days in May 1978 and 37 in May 1979.

SPECIES	No. caught		No. banded 1978- retrapped 1979
	1978	1979	
White-breasted Robin <i>Eopsaltria georgiana</i>	19 (3)	20 (5)	2
White-browed Scrubwren <i>Sericornis frontalis</i>	9 (2)	13 (1)	1
Golden Whistler <i>Pachycephala pectoralis</i>	7	8 (1)	1
Black-faced Cuckoo-shrike <i>Coracina novaehollandiae</i>	-	8	
Scarlet Robin <i>Petroica multicolor</i>	3 (1)	7 (2)	
Inland Thornbill <i>Acanthiza apicalis</i>	4	5	
Rufous Treecreeper <i>Climacteris rufa</i>	-	5 (1)	
Red-winged Fairy-wren <i>Malurus elegans</i>	10 (2)	4 (1)	
White-naped Honeyeater <i>Melithreptus lunatus</i>	1	4	1
Grey Fantail <i>Rhipidura fuliginosa</i>	4	3	
Red-eared Firetail <i>Emblema oculata</i>	2	2	
Grey Shrike-thrush <i>Colluricincla harmonica</i>	2	1 (1)	1
Dusky Woodswallow <i>Artamus cyanopterus</i>	-	1	
New Holland Honeyeater <i>Phylidonyris novaehollandiae</i>	-	1	
Laughing Kookaburra <i>Dacelo novaeguineae</i>	-	1	
Splendid Fairy-wren <i>Malurus splendens</i>	4	-	
Silvereye <i>Zosterops lateralis</i>	1		
Total	66	83	6

Numbers in parentheses are the numbers of each species retrapped during each year.

taken of the small numbers of the most common species that were re-trapped within each year, then many individuals probably remain in the same area after burning.

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SEASONAL FLUCTUATIONS IN NUMBERS OF THREE SPECIES OF TERN IN NORTHERN TERRITORY

Storr (1977) reviewed records of Crested *Sterna bergii*, Lesser crested *S. bengalensis* and Whiskered *Chlidonias hybrida* Terns from the Northern Territory. Notes on feeding of *C. hybrida* in sub-coastal areas have been given by Crawford (1977). In the Indian region, Henry (1971) and Ali and Ripley (1969) described *S. bengalensis* as 'a blue-water species' and *S. bergii* as neritic. Observations on the northern Australian coast indicate that *S. bengalensis* regularly occurs inshore often in the company of *S. bergii* (Crawford 1972; Serventy *et al.* 1971).

All three species are known to undergo seasonal movements. Here, I describe fluctuations of numbers of these species as shown by weekly censuses on the coast and for *C. hybrida* at Fogg's Dam. The Dam is forty-five kilometres south-east of Darwin and the five coastal study sites were in Darwin Harbour and along the coast

east of the city. A map of the area appears in Crawford (1972).

ENVIRONMENT AND METHODS

The climate is described by McAlpine (1969). The wet season usually starts in December and ends in March or April. Hot humid weather occurs from late September to November and during April but little of the annual rain (av. 1,500 mm) is received during these periods. The cool and almost rainless dry season lasts from May to September.

During the wet season, the extensive subcoastal plains are usually inundated and other habitats for waterbirds occur well inland. In the dry season, the wet lands are reduced to a small fraction of their wet-season area, and waters like Fogg Dam become important refuges for many birds (Crawford 1979a). The Fogg Dam area con-

sisted of approximately seventeen hectares of sedge plain and lily-covered deeper-water lagoon. Observations were made weekly from April 1970 to January 1972.

The coastal habitat consisted of sandy beaches, estuarine mud flats and flat reefs. Study sites were at Sandgrove Creek, Darwin Wharf, East Point, Lee Point and Cameron Beach. A weekly census was made from July 1970 to December 1971. East Point and Lee Point were visited at high tide.

In the dry season, discharge of fresh water into estuarine areas is low in contrast to the wet season when rivers are often in full flood (Forbes 1963; Williams 1969). Crawford (1979b) suggested that freshwater drainage produced wildly fluctuating levels of salinity, causing a disruption of food chains. Discharge from the land is rich in nutrients and, once conditions stabilize in the dry season, there ought to be a rapid increase in production (Rodriguez 1975). Seasonal changes in temperature of surface water were not evaluated; this can be an important factor in the distribution of some pelagic species (Jehl 1973, 1974; Barton 1979).

The variation in size of body and colour of bill within *S. bergii* and *S. bengalensis* was such that a few individuals could not be separated as being of one species or the other, even at close range with x 10 binoculars. These birds were disregarded. Subadult *C. hybrida* were distinguished from White-winged Terns *C. leucoptera* in non-breeding plumage, by their slightly longer tails and more robust bills. The *C. leucoptera* were a long-billed Asian type, which differs from the short-billed European birds.

RESULTS AND DISCUSSION

Chlidonias hybrida

Figure 1a shows the fluctuations of numbers of *C. hybrida*. Before I started the coastal census, I recorded only one during visits to the coast between March and June 1970. Most coastal records were from Sandgrove Creek and the wharf in Darwin Harbour, where they were either resting or foraging.

Chlidonias hybrida seems to breed inland during the wet season (Storr 1977; Ingram 1907). In the 1969–70 wet season, small numbers remained on the sub-coastal plains, probably because rain had been inadequate inland and breeding conditions were poor. The numbers that subsequently moved to the coast in the dry season of 1970 were greater than in 1971, following a good wet season (Fig. 1a). *C. hybrida* seems to use the coast as a dry season refuge as do several other species (Crawford 1979b). Their arrival on the coast may not only reflect the lack of inland habitat but also the onset of the favourable season in coastal area. Their disappearance may result from a reversal of this.

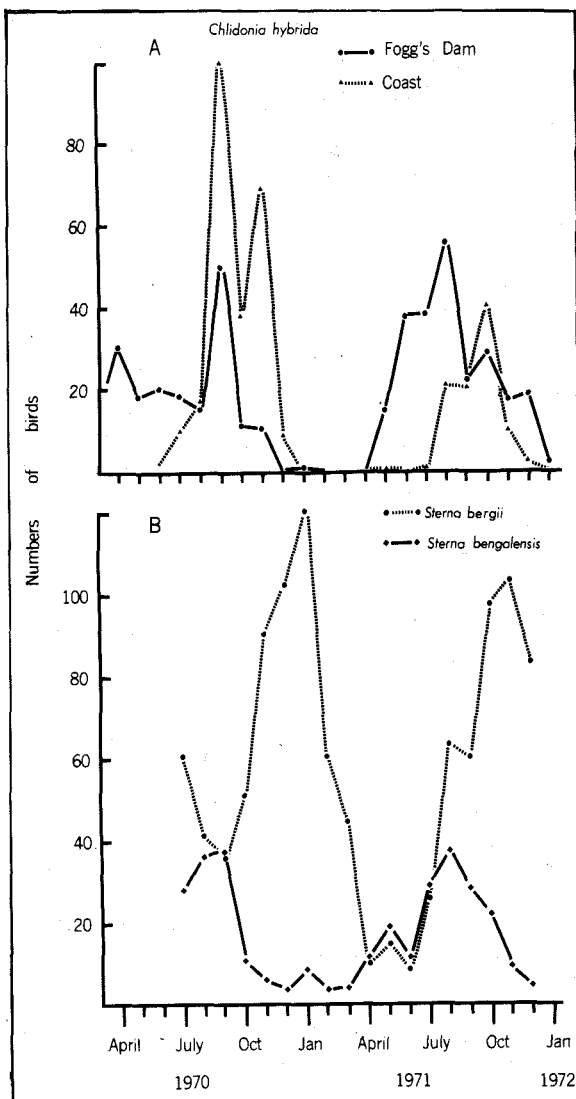


Figure 1. Fluctuations of monthly means of numbers: (a) *Chlidonias hybrida* at Fogg Dam and the coast; (b) *Sterna bergii* and *Sterna bengalensis* in coastal sites.

Sterna bergii and *Sterna bengalensis*

S. bergii and *S. bengalensis* were most often seen resting at high tide on the rock platforms and raised sand-banks of East Point and Lee Point. Figure 1b shows their fluctuations in numbers. During the coastal censuses, the maximum numbers of indigenous birds was reached in September–October in both 1970 and 1971. Numbers of *S. bengalensis* decreased in these periods, whereas *S. bergii* did not reach maximum numbers until the early part of the wet season (December). Hoogerwerf and Siccama (1937) and Glenister (1951) describe *S. bengalensis* and *S. bergii* as

(northern) winter visitors to Java and Malaya. Glenister also says they are passage migrants and Nesbit (1965) and Darnell (1965) indicate an emigration of *S. bengalensis* in the Singapore Straits and on the western coast of Malaya between August to October. There seem to be too few records of either species in the Borneo region for seasonal occurrence to be ascertained (Smythies 1968) and only *S. bergii* is known from the Philippines (Du Pont 1971). The passage movement of *S. bengalensis* in the Malayan region is fairly closely synchronized with the apparent passage in Darwin (Fig. 1b) and the appearance of this species as a summer visitor to parts of Western Australia (Serventy and Whittell 1967; Sedgwick 1978) but this may be coincidental. The seasonal movements of *S. bergii* have been described for southern Australia by Carrick *et al.* (1957) but nothing seems to be known from northern Australia. The peak in numbers of *S. bergii* in the early wet season (Fig. 1b) may be related to the arrival of birds from the northern hemisphere in Java but, again, this may be coincidental.

Both species of *Sterna* prey on fish and might be adversely affected by turbid water during the wet season. In 1970 and 1971 heavy rains in December coincided with the peak numbers of *S. bergii* (Fig. 1b). G. M. Storr (*in litt.*) suggests that the Asian *S. bergii* and *S. bengalensis* may be better adapted to muddy water than the indigenous populations. There are more large muddy rivers in Asia than Australia and some of these may influence conditions far from their mouths (Rodriguez 1975).

If the fluctuations in numbers of the two species of *Sterna* resulted from the movements of the Australian populations alone, then they could be related to the local breeding cycle. Both species breed mainly from October to December in eastern coastal Queensland (Storr 1973; Noske 1974; Warham 1977) and probably April to September in other parts of northern Australia (Storr 1977; Kolichis 1977; Bush and Lodge 1977). Post-breeding dispersal of the north-western Australian population of *S. bergii* could explain the peak in the early wet season (Fig. 1b) but this seems inadequate for *S. bengalensis*, unless they had an earlier breeding season.

S. bergii and *S. bengalensis* appear taxonomically close. Their niches may overlap, so that some mechanism would have to operate if one species was not to be excluded from part of its present range. Such mechanisms are only likely with a limited resource (Pielou 1975); in this case, food or nesting sites might be critical. *S. bergii* was frequently seen foraging close to the shore, whereas *S. bengalensis* seemed to have flown farther out to sea after leaving the high-tide roosts. R. E. Johnstone (*in litt.*) says that *S. bengalensis* forages over deep water off the Kimberley coast (Smith *et al.* 1978). This suggests a separation of feeding niches. Similarly, if the two species of *Sterna* were using the same breeding islands, they might be doing so at different times but present indications are that this is not

so. All these aspects need further investigation.

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A SURVEY OF THE BIRDS OF TWO AREAS OF SCLEROPHYLL BUSHLAND IN SOUTHERN TASMANIA

The avifauna of two areas of uninhabited sclerophyll bushland, selected for their widely different rainfall and vegetation, was surveyed between November 1977 and May 1979. One of these areas was in the Snug Plains, consisting of regions of wet sclerophyll, wet scrub and sedgeland on undulating hills at an altitude of about 500-600 metres, twenty-six kilometres south-west of Hobart. The other area was typical dry sclerophyll bushland on undulating hills, of relief between 100 and 500 metres, on the eastern bank of the Derwent River just east of Hobart near the Risdon Brook and Flagstaff Gully Reservoirs and embraced the slopes and summits of Mt Direction, Gunners Quoin, Grasree Hill, Craigow Hill and Flagstaff Hill. Except for a few jeep tracks, both areas were unmodified native bushland, with no artificial clearings or paddocks. Visits were made to each area once or twice a month but not in any regular pattern, resulting in nineteen visits to Snug Plains and twenty-one to Risdon-Flagstaff. No visits were made during July and August. Results of the survey are presented in Table I, which shows the number of visits in which each listed species was seen or heard. Totals of fifty and forty-nine species were observed at Snug Plains and Risdon-Flagstaff respectively.

Of interest are those species which appeared exclusively or predominantly in one or other of the survey areas. For example, if we omit species recorded on less than three visits, then the Swamp Quail, Richard's Pipit, Pink Robin, Olive Whistler, White-browed Scrubwren, Scrubtit, Calamanthus, Tasmanian Thornbill and New Holland Honeyeater were recorded only in the Snug Plains area and, by a test for equality of binomial proportions, the Beautiful Firetail and Black Currawong were observed more frequently there than in Risdon-Flagstaff ($p < 0.01$). Conversely, the Peregrine Falcon, Pallid Cuckoo, Laughing Kookaburra, Spotted Quail-thrush, Yellow-rumped Thornbill, Noisy Miner, Grey Butcherbird, Australian Magpie and Grey Cur-

rawong were recorded only in Risdon-Flagstaff. None of the above observations contradict any notions held about habitats of birds in Tasmania.

The Blue-winged Parrot was seen at Snug Plains during the months November to March and was observed to be nesting in tall eucalypts at the edge of a marshy plain. Because this species was also seen on about one-quarter of the visits to Risdon-Flagstaff, it appears to be more abundant in the forested areas near Hobart than has hitherto been noted. Although the Tasmanian Nativehen and Scarlet Robin have increasingly become associated with man-made artificial habitats such as paddocks and clearings, their occurrence at Snug Plains shows that they still appear in natural habitats. The Brown Thornbill was recorded during each visit to Snug Plains. We have seen this species in similar habitats and elevations in numerous other Tasmanian localities in the past few years and it is clear to us that it has a wide range of habitats, a fact not yet generally acknowledged by many Tasmanian bird observers. The Southern Emu-wren is probably more common in Snug Plains than indicated by the two observations recorded in this survey but its secretive nature makes it difficult to detect. Some other species, such as the New Holland Honeyeater and Beautiful Firetail, occur in many habitats and may have been recorded more often at Snug Plains simply because several individuals may have been resident there. Similarly, a pair of Peregrine Falcons was nesting on Gunners Quoin and these same individuals were seen repeatedly during visits. Perhaps the most exciting single sighting was that of an Orange-bellied Parrot, a rare and endangered species, at Snug Plains on 6 November 1977. A solitary individual emitted its characteristic alarm call as it flew from the ground to a nearby shrub. For several minutes we observed its bright emerald-green upper plumage, which contrasted markedly with that of a pair of Blue-winged Parrots that we had watched closely half an hour earlier.

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