

# THE DISTRIBUTION OF *TRIOPS* AND *LEPIDURUS* (BRANCHIOPODA) IN AUSTRALIA

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## INTRODUCTION

Several 'species' of the Notostraca have been described from Australian inland waters. All were recently assigned by Longhurst (1955) to either *Triops australiensis australiensis* (Spencer & Hall, 1895) or *Lepidurus apus viridis* Baird, 1850. Assigned to the former were *T. gracilis* Wolf, 1911, and *T. strenuus* Wolf, 1911; to the latter were assigned the Australian forms *L. viridis* Baird, 1850, *L. angasi* Baird, 1866, and *L. viridulus* Tate, 1879. *T. australiensis australiensis* is endemic to mainland Australia, and *T. australiensis sakalavus* (Nobili, 1905) its only conspecific relative, to Madagascar (Longhurst, 1955). *L. apus viridis* occurs in New Zealand and Australia (including Tasmania), but the nominate subspecies is more or less cosmopolitan, and other subspecies occur in the Mediterranean area, South America and California. In view of the extensive distributions of single notostracan species, and the fact that there are no overlaps in the geographical distributions of congeneric species or subspecies of *Triops* or *Lepidurus* (cf. Linder, 1912; Longhurst, 1955), it seems probable in the opinion of the writer that these are the only taxa of the Notostraca in Australia.

The present paper, however, deals only at the generic level, for the small number of specimens in each of the samples studied precluded any attempt to delimit precisely species or subspecies. As noted by Gurney (1924), Barnard (1929), Linder (1952) and many others, the separation of species and subspecies within *Triops* or *Lepidurus* is difficult because of the great extent of phenotypic variation, and should not be attempted for samples with few specimens (Linder suggested that at least 50 to 100 specimens were necessary to cover most of the variation). All of the samples on which this paper is based contained few specimens, and therefore no examinations beyond the determination of the presence or absence of a supra-anal plate were carried out. Specimens which possessed a supra-anal plate were regarded as species of *Lepidurus*; those without one were regarded as species of *Triops*.

Several general statements have been made concerning the differential geographical distribution of the genera in regions where both occur. With reference to Australia, the statements of Spencer & Hall (1896: 234), Barnard (1929: 228) and Riek (1959: 252) may be noted: in effect, all three state that *Triops* is found

inland, whereas *Lepidurus* occurs in coastal districts. None of these statements, nor the general comments on generic distributions by Sayce (1903), Wolf (1911), Dakin (1914) and Henry (1924), is accompanied by a map and all appear to be based on few records. As *Triops* is known to occur near the coast and *Lepidurus* inland, it has been thought worthwhile to describe the Australian distribution of the genera more precisely, and the attempt forms the basis of this paper.

The following discussions are based on 189 different locality records corn-prizing 100 for *Triops* and 89 for *Lepidurus*. These have been assembled from three sources:

(1) Museum material. All material in the National Museum, Melbourne (50 collections), Australian Museum (54), Western Australian Museum (30), Tasmanian Museum and Art Gallery (8), South Australian Museum (5), Queensland Museum (6) and Queen Victoria Museum (5) has been examined either personally or by curators clearly aware that *Lepidurus* has a supra-anal plate, and *Triops* has not. Not all museum data could be used because of uncertainty as to the exact position of some collections.

(2) Other material. This comprises collections made either personally or for me (19 collections).

(3) Records in the literature. Only records which are obviously those of an author aware of the generic differences, which refer to an exact locality, and which are not duplicated (as a number are) in Australian museum collections were used. The papers of Baird (1866), Tate (1879), Spencer & Hall (1895, 1896), Armitage (1909), Smith (1909), Wolf (1911), Chilton (1917), Henry (1924), Main (1953) and Longhurst (1955) proved useful, though not all records within any one paper could be used. Because of uncertainties as to position or genus, or because of duplication, the records of Baird (1850), Brady (1886), Sars (1894), Shephard (1898), Sayce (1903), Dakin (1914), Alexander (1914), Gurney (1927), Pope (1949), Guiler (1952) and McNeill (1952) were discounted. The total number of previously published records used is 21.

Longhurst (1955: 35) mentioned his use of an unpublished map prepared by the late L. Glauert and showing the distribution of *Triops* and *Lepidurus* in Western Australia. On enquiry from Dr. George (Western Australian Museum), Mr. R. W. Ingle (British Museum) and Dr. A. R. Longhurst (Scripps Institution of Oceanography), it appears that this map is no longer available. Dr. Longhurst (personal communication, 18 May 1964) informed me, however, that the map was simply a plot of all notostracan collections of the Western Australian Museum.

Apart from placing on a rather more precise basis our knowledge of the distribution of *Triops* and *Lepidurus* in Australia, the present paper is thought to be of some general ecological interest in that it deals with the distribution of two ecologically rather similar taxa which are allopatric for parts of their total geographical range yet sympatric over a considerable area, and whose distribu-

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tions in view of their resistant eggs and apparent ease of dispersal are probably little influenced by historical factors.

In addition to the main discussion concerned with geographical distribution, the paper includes some additional observations of an ecological nature.

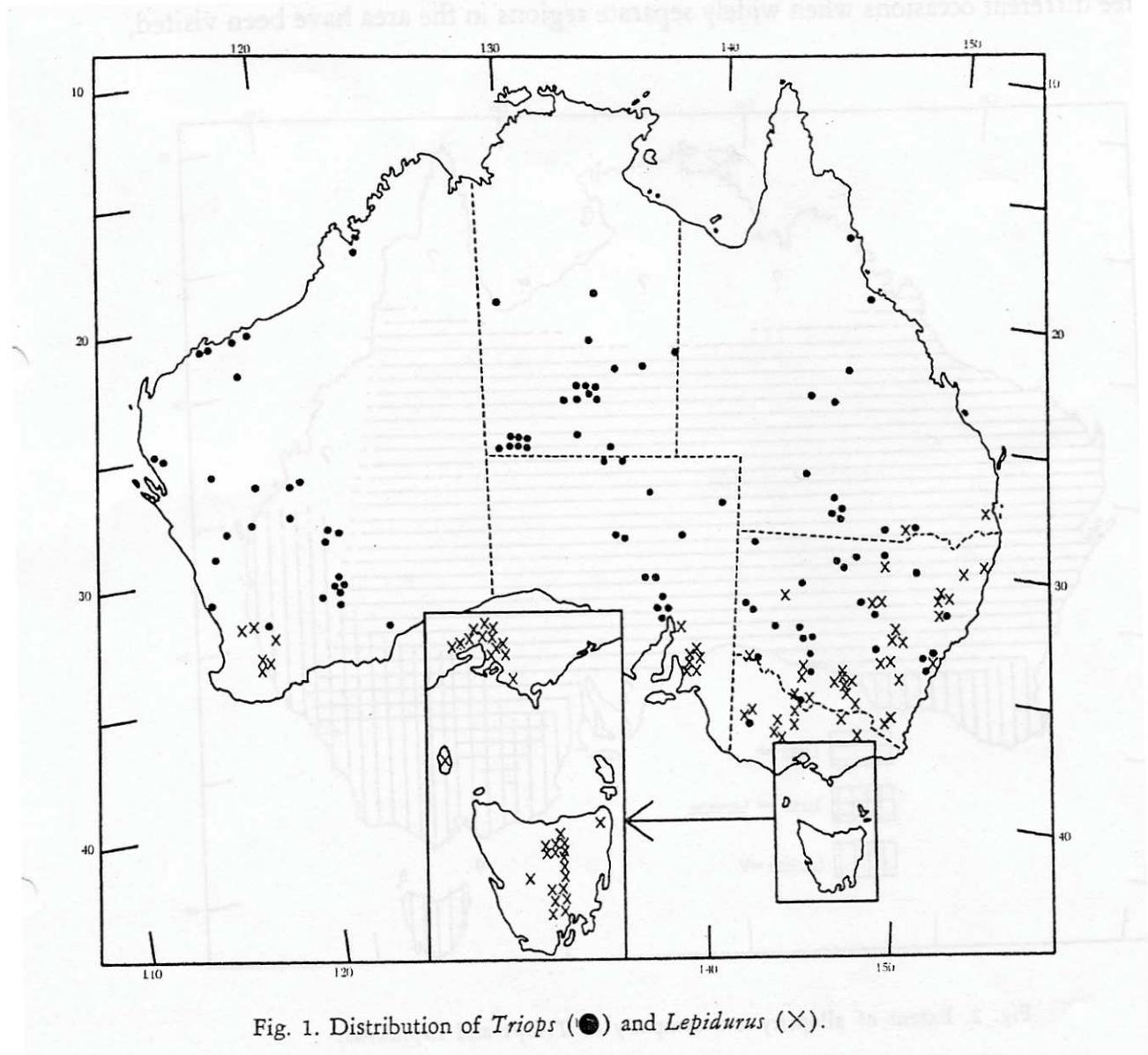


Fig. 1. Distribution of *Triops* (●) and *Lepidurus* (×).

### GEOGRAPHICAL DISTRIBUTION

A map showing the exact position of all reliable records of *Triops* and *Lepidurus* is reproduced in fig. 1, and the extent of generic allopatry and sympatry is tentatively indicated in diagrammatic form in fig. 2. A number of conclusions concerning gross geographical distributions may be drawn from these figures.

Both genera occur in all states except Tasmania, where only *Lepidurus* has so far been recorded (19 records); only *Triops* has been recorded from the Northern Territory. All records of *Lepidurus* are confined to the south-eastern quarter or to the extreme south-western corner of Australia; outside these regions only *Triops* is found. Over a large part of the south-east, and perhaps slightly in the south-

western corner also, the generic distributions overlap; in areas other than these, allopatric distributions appear to be maintained.

The absence of records from the north of Australia precludes any definitive statements concerning distributions in that area. It may be mentioned, however, that on three different occasions when widely separate regions in the area have been visited,

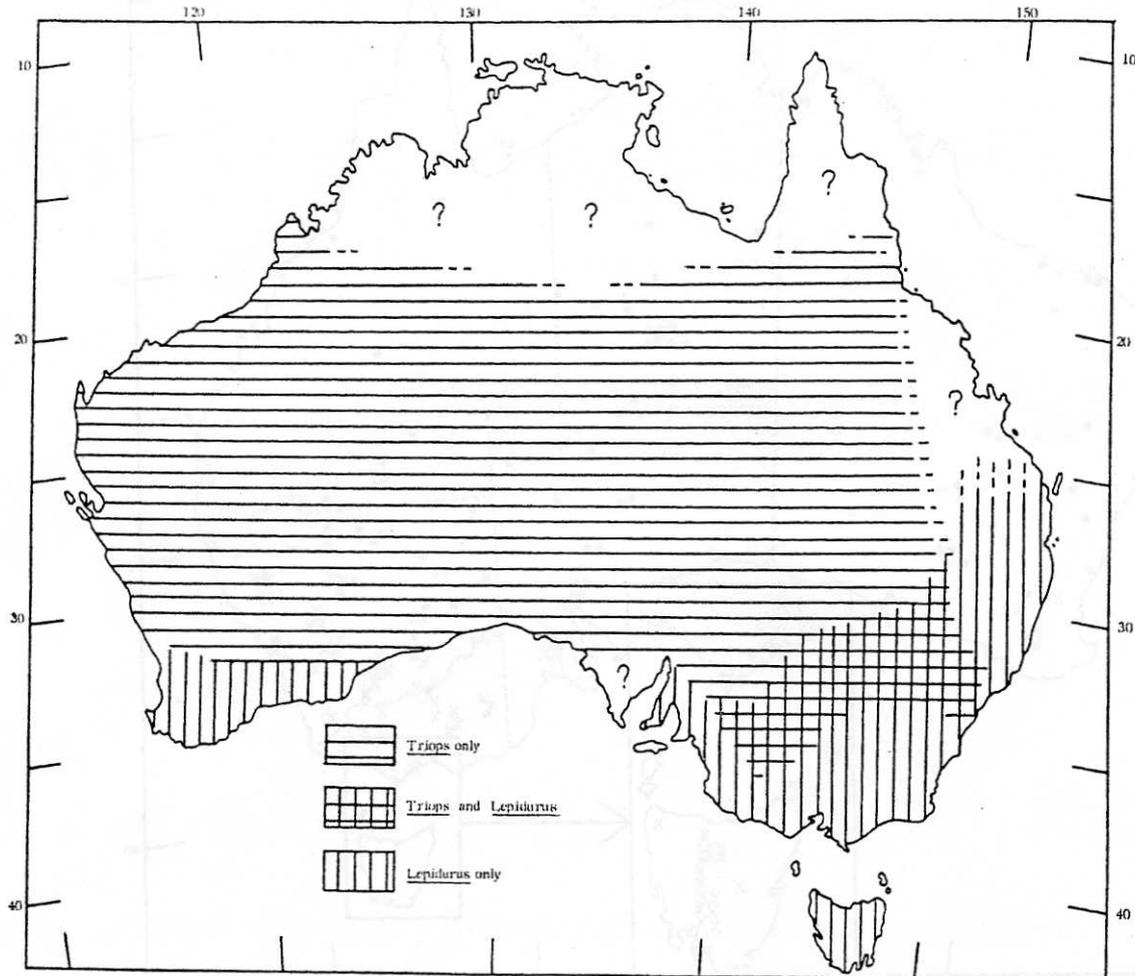


Fig. 2. Extent of allopatry and sympatry of *Triops* and *Lepidurus*.

no Notostraca were ever recovered even though specific attempts were made to collect specimens. None was found in the region around Darwin, Northern Territory (5 localities searched, September 1962), in the Cape Bedford - Cairns region of the Cape York Peninsula, Queensland (12 localities, February 1965) or in the Kimberley region of Western Australia and the adjacent north-eastern region of the Northern Territory (23 localities May and June 1965). Moreover, Riek's (1959: 250) statement that "*Apus* [sic], the tadpole shrimp, could become a pest in rice plantings in the Northern Territory" seems unjustified, for it appears that notostracans are unknown in rice plantations at Kununurra Agricultural Research Station (P. E. Madge, personal communication, 27 August 1965). This is located

at the northern end of the border between Western Australia and the Northern Territory. Notostraca are known as frequent pests of rice plantations outside Australia (cf. Crossland, 1965; Grigarick, Lange & Finrock, 1961). It seems that the absence of records from northern Australia reflects a true absence of Notostraca and not merely the paucity of collections due partly to inaccessibility.

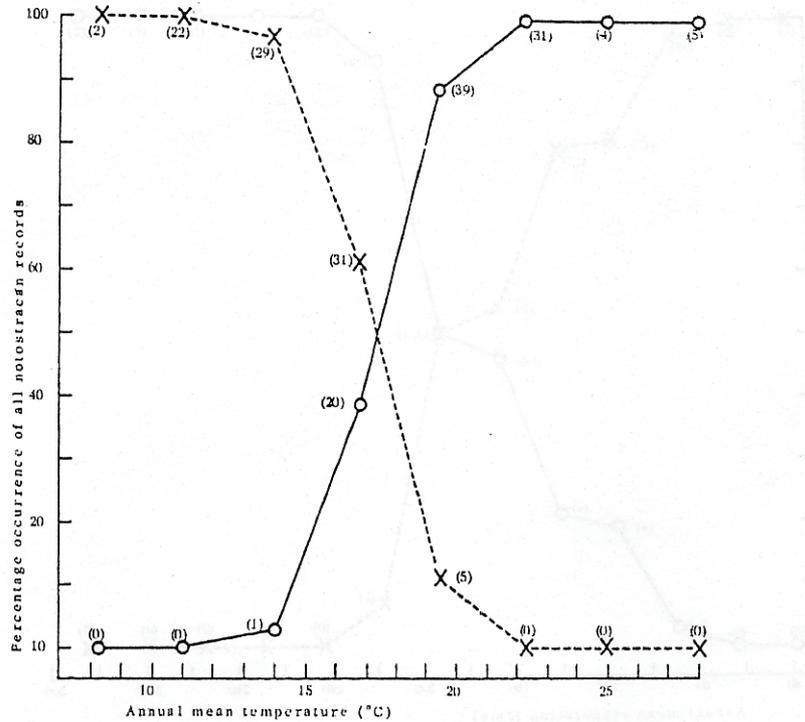


Fig. 3. Distribution of *Triops* (o—o) and *Lepidurus* (X—X) with respect to isotherms of annual mean temperature. Figures in brackets indicate absolute numbers of records.

With regard to former ideas concerning the geographical distribution of the genera, figs. 1 and 2 indicate that the general statements of Spencer & Hall (1896), Barnard (1929) and Riek (1959) to the effect that *Triops* occurs inland and *Lepidurus* at the coast now require modification; clearly, *Triops* occurs near the coast in several regions, and *Lepidurus* has been found well inland on a number of occasions. The occurrence of *Triops* on the east coast has been explained by Pope (1949) and Riek (1959) as due to strong westerly dust storms which have blown eggs from the interior. Transport of eggs on the feet of birds is another feasible explanation.

In so far as the absence or northern records permits, it is possible to suggest that the geographical distributions illustrated in figs. 1 and 2 bear some correlation with regional climatic differences. As both *Triops* and *Lepidurus* inhabit a wide variety of inland waters and have eggs which are small, resistant to desiccation and therefore easily dispersed, this correlation may be a causal one and not merely indirect or incidental. Those climatic factors which seem of most importance are annual mean temperature and evaporation. Figs. 3 and 4 indicate the extent of the correlation between these and the occurrence of *Triops* or *Lepidurus* when

generic distribution records are plotted as percentages of all notostracan records between given isoclines of annual mean temperature and evaporation. It is possible that high temperatures inhibit the occurrence of the Notostraca in northern Australia.

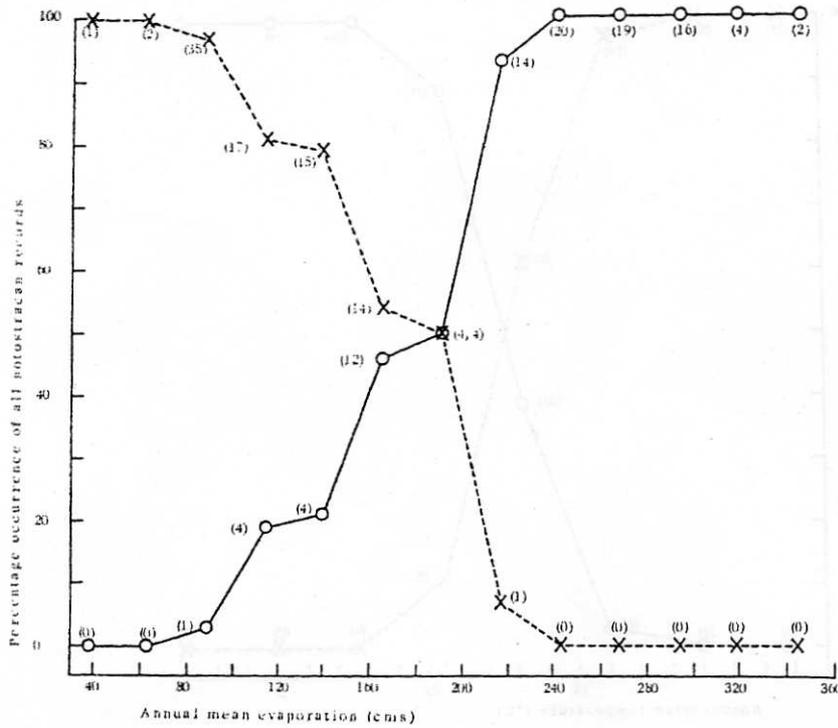


Fig. 4. Distribution of *Triops* (o—o) and *Lepidurus* (X—X) with respect to isoclines of annual mean evaporation. Figures in brackets indicate absolute numbers of records.

ADDITIONAL OBSERVATIONS

Co-existence of genera. - In view of the fact that sympatric distributions are maintained over a large area in south-eastern Australia, it is noteworthy that the genera have never been recorded in the literature as co-existing in any Australian locality. None of the collections examined during the present study, also, were noted as containing specimens of both *Triops* and *Lepidurus*. Outside Australia, the two genera have only rarely been reported from the same locality (cf. Linder, 1952).

Season of occurrence. - An attempt was made to ascertain the periods of occurrence of *Triops* and *Lepidurus* by plotting on a regional basis the time of collection of all material with this information noted. Limited though the information was, it seems reasonable to draw some general conclusions. In Victoria and Tasmania, *Lepidurus* occurs mainly in spring, during the months of September and October, but it may also occur sporadically in summer or winter. A similar main period of occurrence of *Lepidurus* is found in New South Wales, although there it begins, rather earlier - in August. *Triops*, on the other hand, occurs in New South Wales only in summer and (mainly) autumn. This apparent seasonal

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difference in the time of main occurrence of the genera perhaps also occurs in South Australia; there, most collections of *Triops* were made in May, whereas *Lepidurus* has been collected during only August, September and October. Insufficient information precludes any statements concerning Queensland. In the Northern Territory, collections of *Triops* have been made at all seasons. Finally, in south-western Australia, all collections of both genera have apparently been made in winter only, and this is in line with Dakin's (1914) and Alexander's (1914) statements on the season of occurrence of the Notostraca in that region of the State. Elsewhere in Western Australia, *Triops* has been collected at seasons other than winter (A. Main, personal communication).

The apparent difference in the principal times of occurrence of the genera in south-eastern Australia, where sympatry occurs over a large area, is of especial interest in connection with current ideas concerning the co-occurrence of ecologically similar taxa. It is perhaps only because of such temporal separation that sympatry is possible. In south-western Western Australia, the apparent lack of temporal separation may explain the apparent lack of any area of sympatry.

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### ZUSAMMENFASSUNG

Die geographische Verbreitung von *Triops* und *Lepidurus* in Australien wird beschrieben und diskutiert. *Triops* kommt überall im Zentrum, im Westen und in Teilen des Ostens vor, ist jedoch abwesend in Tasmanien, im äussersten Süd-Westen und Süd-Osten und augenscheinlich auch im Nördlichen Australien. *Lepidurus* kommt im Süd-Westlichen und Süd-Ostlichen Australien vor, einschliesslich Tasmanien. Die Rassenvorkommen überlappen in einem grossen Areal des Süd-Ostens. Die Korrelationen zwischen Verbreitung und einige klimatische Faktoren sowie einige Beobachtungen allgemein-ökologischer Natur werden erörtert.

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