

(recurrent parent used in this study) background and those with IR24 background could also be distinguished. Nevertheless, of the 114 F₂ plants screened, 27 were found to be homozygous resistant (RR), 55 heterozygous (Rr) and 32 homozygous susceptible (rr) following the normal Mendelian ratio of 1:2:1. The selected homozygous resistant plants will be used for further advancing the breeding material.

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Cheliped laterality in freshwater prawn, *Macrobrachium nobilii* (Henderson and Matthai, 1910)

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A field study was undertaken to find out the cheliped laterality in the freshwater prawn *Macrobrachium nobilii* which inhabit the river Cauvery. Among 664 *M. nobilii* collected from three sites over a period of three months, 553 possess differentiated chelipeds with major and minor chela distributed on right or left side. In overall population and in site two, male-handedness deviated from the expected 1:1 ratio, when compared with female.

CHELIPED, the multi-functional organ in decapod crustaceans has drawn much attention due to its versatile use in foraging¹, agonistic and aggressive interactions at

inter- and intra-species level^{2–4}, and mate selection^{5,6}, handling and guarding⁷. Simultaneously the morphometric features of cheliped also have gained equal importance. Based on their morphology, the chelipeds are classified into major (crusher with molariform teeth) and minor (cutter with pointed teeth laden with abundant setae)⁸. Sexual dimorphism in cheliped size is also recorded in some species⁹.

In decapods, handedness or laterality is the possession of dimorphic claws with one larger than the other¹⁰. The animal is called right or left-handed, based on the location of major chela on the corresponding side. Among the right and left-handed animals, the former wields more functional advantages like breaking dextral gastropod shell and resources utilization^{10,11}. Even distribution of handedness and/or its deviation from right or left has been reported between and within species. For example in *Ocypode quadrata*, half of the sampled population are right-handed¹² but in *Ocypode gudicchaudii*, the occurrence of major chela is essentially skewed to the left¹³. When the major chela is automized, minor chela becomes the major and the regenerated one becomes the minor leading to reversal of handedness¹⁴. This had led to a controversy over the use of chela as a dependable taxonomic character.

Studies on other decapods like lobster, *Homarus americanus*^{15,16}, stomatopod, *Gonodactylus falcatus*¹⁷, crayfish, *Orconectes rusticus*³, and freshwater prawn, *Macrobrachium rosenbergii*² have focused on the functional advantages of chelipeds in aggressive interactions and displays. In *Macrobrachium* spp, there are a few studies, which report only on the size of the cheliped and not on handedness^{18,19}. *Macrobrachium nobilii*, an endemic prawn, inhabiting river Cauvery is called as stone prawn due its affinity to seek shelter under boulders. It is aggressive and at a given time 16.4% of the population suffers autotomy²⁰. This paper reports on the handedness in *Macrobrachium nobilii*.

M. nobilii was sampled in three different sites – Jedarpalayam (a minor check dam), Upper Anicut (a major reservoir) in river Cauvery and Check Post point in Colleron river (a tributary of Cauvery) near Tiruchirapalli (10.50°N; 78.43°E) during May to July 1997. Each time about 75 ± 5 (Mean ± SD) prawns were collected at random by using hand net with equal amount of fishing effect from 0600 to 0800 hours and sorted out into juveniles (30 ± 5 mm), males (45 ± 5 mm) and females (40 ± 5 mm). Juveniles were not considered for the study since handedness between chelae is discernible only on attaining sexual maturity¹³. The occlusive surface of major chela contains abundant 'molariform' teeth but minor chela possesses pointed teeth laden with numerous setae (Figure 1). Based on this, the data on handedness recorded separately for males and females were tested through χ^2 test²¹.

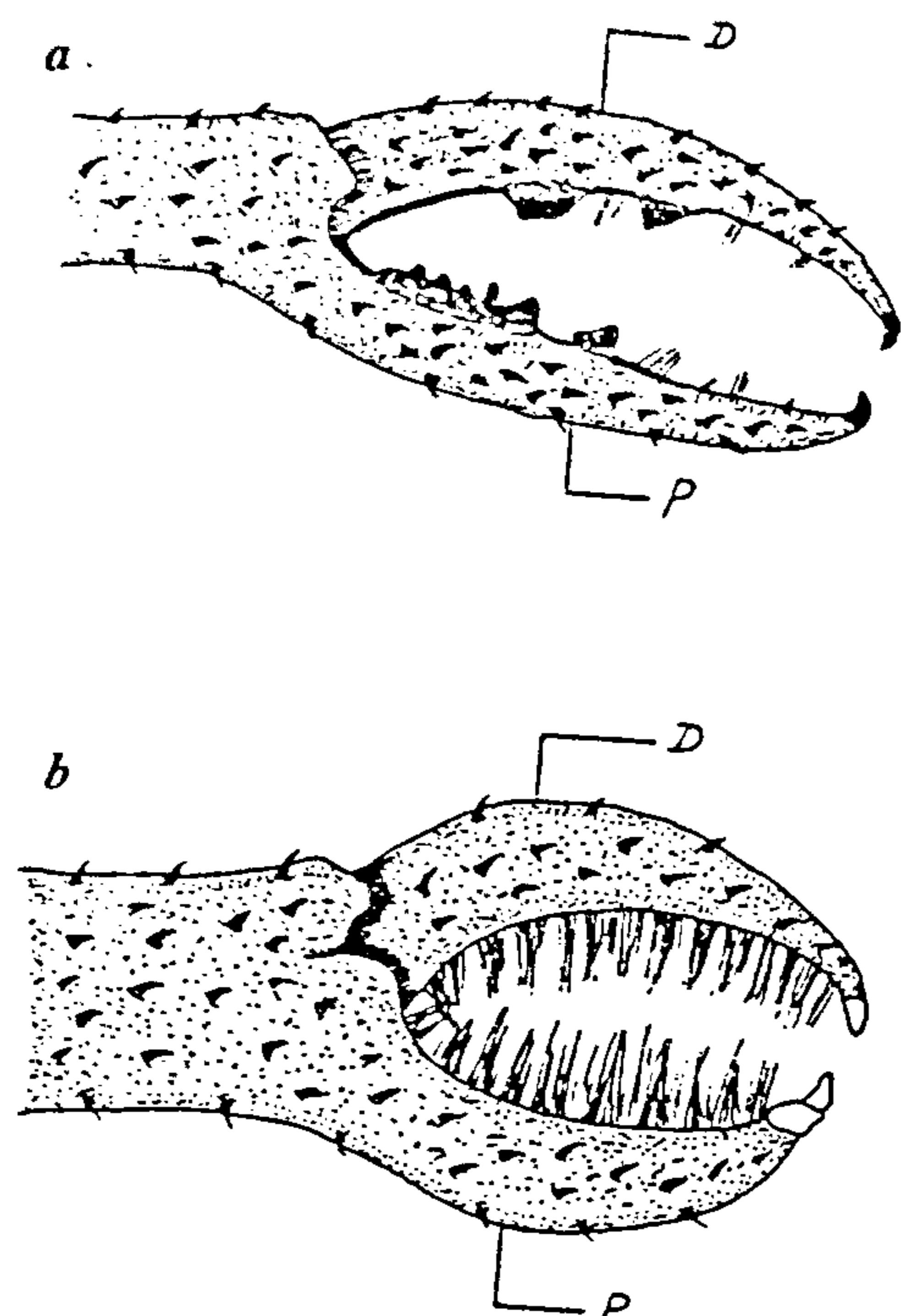


Figure 1. *Macrobrachium nobilii*. Morphological variations in the propodus of (a) major and (b) minor chela. D, Dactylus; P, Propodus.

Table 1. Population structure of *M. nobilii* collected in three sites

Site	Juvenile	Male (nos)	Female	Sex ratio M:F
Jedarpalayam	43	57	125*	1:2.1
Upper Anicut	35	69	140*	1:2
Check post	33	51	111*	1:2.1
Total	111	177	376*	1:2.1
Population (%)	16.7	26.6	56.6	

*Statistically significant $P < 0.05$.

Among a total population of 664 *M. nobilii*, females (56.5%) were more abundant than males (26.6%) and juveniles (16.7%). Sitewise also, the female population is dominant ($P < 0.05$) (Table 1). Among the pooled population data and in site 2 (Upper Anicut), 58.75% and 69.5% of the males are right-handed ($P < 0.05$). Among males such deviation from 1:1 ratio in handedness may occur due to reversal of cutter to crusher type as a result of loss of major chela as observed in *Uca lactea*²². The prevalence of right-handedness in site 2 may be adduced to the unique habitat conditions like increased resource competition or availability of specific types of food like gastropods leading to reversal of handedness²³.

Table 2. Handedness in three field populations of *M. nobilii*

Site and group	Right handed animals (no)	Right handed animals (%)	Ratio (R:L)
Jedarpalayam			
Males	57	29	50.8
Females	125	67	53.6
Total	182	96	52.7
Upper Anicut			
Males	69	48	69.5*
Females	140	60	42.8
Total	209	108	51.6
Check post			
Males	51	27	52.9
Females	111	63	56.75
Total	162	90	55.5
Grand total			
Males	177	104	58.75*
Females	376	190	50.5
Total	553	294	53.1

*Statistically significant $P < 0.05$.

Like males in site 1 and site 3, all females are even-handed ($P < 0.05$) with an equal distribution of right and left-handedness (Table 2). Such an even distribution of handedness irrespective of sex has been reported in other decapods also (*H. americanus*²⁴; *Xantho exaratus*, *Chlorodopsis melanochira*²⁵ and *O. quadrata*¹²).

Cheliped laterality may vary even between related species as a function of their feeding habits. For instance, among predatory species of Ocipodidae, the right major chela is more robust, aiding effectively in prey capture and manipulation²⁶; while in related non-predatory (deposit feeding) and primitive taxonomic groups, handedness is absent²⁷. However, the slender chelipeds also have a dual role in diet manipulation and as organs of offence and defence.

It is pertinent to note here the loss of cheliped during the aggressive interactions in *M. nobilii*. In *M. nobilii*, 10.9% of juvenile, 15.2% of males and 22.3% females have incurred limb loss due to predation pressure and competition for shelter¹⁹. Moreover it is explained that variation in laterality of cheliped in decapods may be due to different selective pressures in relation to geographic and/or ontogenic variations²⁸. This study reveals that essentially in *M. nobilii* there is an even distribution of handedness.

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Neogene deformation of Siwaliks affected by the Delhi-Hardwar ridge as seen in satellite data, India

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The Siwalik ranges east of Hardwar exhibit deformation pattern not akin to the general deformation trend of the Siwaliks elsewhere in the western Himalaya. Satellite image (IRS-LISS-II) of the region displays remarkably deformed Siwalik in this region. The deformation pattern reveals that these structures might have been primarily caused by the Delhi-Hardwar ridge. There has been compressional tectonics which were generated due to westward thrusting movement of rocks across the N-S trending Mithawali thrust and obstruction by the shallow buried NNE trending Delhi-Hardwar ridge.

LOWEST topography in the Himalayan orogen is represented by the Siwalik ranges occupying the depression in front of the higher Himalayan mountain belt. Prior to the formation of mountain belt, Siwalik sediments piled up resting on the Indian plate having a northward slope. Subsurface ridge like structural features as an integral part of the Indian plate might have played an important role in generating distinct deformational structures in the overriding rock mass. The Delhi-Hardwar ridge has been identified as shallow buried structural feature on the basis of geological, geophysical

and aeromagnetic investigations in the western Indo-Gangetic plains¹.

The youngest tectonic unit, the Siwalik range, extends all along the foothills of the Himalayan mountain belt comprising mollasse sediments subjected to folding and thrusting under compressional tectonism. However, these rocks escaped the vigour of tectonic activity that suffered by the higher Himalayan ranges. In fact, Siwalik rocks in the Dehra Dun valley show less deformation and are mostly represented by the inclined beds (one limb of fold) in the foothills region. But on satellite image, intense folding in Siwalik rocks east of the Hardwar may be observed. It appears that the deformation has been affected due to interaction of other structures as well, which needs proper attention. Figure 1 shows the study area and generalized tectonic setup.

On the structural aspect of the Siwalik range of Dehra Dun region²⁻⁹, considerable information has been published and the Siwalik ranges recently have been mapped in detail¹⁰ (Figure 2). But, the remarkable Siwalik structures between Hardwar and Laldhang escaped the attention of many.

With the advent of satellite images having synoptic view, higher spatial and better spectral resolution, it has become possible to recognize deformation structures having tectonic significance in a better and more reliable way. Hitherto, the minor structural changes could not be realized on ground mapping which has always a limited coverage. This limitation acted as a hindrance to recognize tectonic significance of the structural features.