

A Comprehensive Review of *Barytelphusa cunicularis* (Westwood, 1836): Taxonomy, Biology, Nutritional Value, Ecology and Research Perspectives

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Abstract

Barytelphusa cunicularis (Westwood, 1836) is a freshwater crab of the family Gecarcinucidae. It is primarily a nocturnal and burrowing species that is widely distributed in rivers, streams, tributaries, ponds, and other freshwater habitats of India. Factors such as substrate characteristics and local environmental conditions appear to influence its habitat use. Available evidence suggests flexible or opportunistic feeding behavior, although its natural diet remains insufficiently characterized. Its reproductive cycle shows marked seasonal activity, with a major reproductive peak during the monsoon period, particularly in June–July. It is an important locally consumed food resource, with proximate analyses indicating appreciable protein and mineral content. The species also has economic and biotechnological potential, including its use as a food commodity and as a source of chitin and chitosan. However, important gaps remain in understanding its natural feeding ecology, population variation, nutritional composition, contaminant accumulation, reproductive ecology, and sustainable utilization. This review summarizes current knowledge of the taxonomy, distribution, habitat, feeding biology, reproduction, nutritional characteristics, and ecological and economic significance of *B. cunicularis*, while identifying priorities for future research.

Keywords: *Barytelphusa cunicularis*; Freshwater crab; Gecarcinucidae; Taxonomy; Feeding biology; Nutritional value; Ecology

1. Introduction

Crabs constitute one of the most diverse and ecologically successful groups of decapod crustaceans, representing a distinct evolutionary assemblage within Brachyura. Their ability to occupy diverse habitats like marine, estuarine, freshwater, intertidal, terrestrial and semiterrestrial environments has led to substantial ecological and morphological specializations (Ng et al., 2008; Tsang et al., 2014). Adaptations like ability to complete their life cycle without a prolonged planktonic larval phase, direct development and parental care of offspring have allowed them to successfully colonize freshwater environments (Cumberlidge and Ng, 2009). They exhibit particularly rich diversity in tropical and subtropical regions, where they occupy streams, rivers, wetlands, seepages, ponds and associated terrestrial microhabitats.

India supports a highly diverse freshwater crab fauna comprising members of the families Gecarcinucidae and Potamidae. Current assessments recognize substantial species diversity and endemism within both families, although the composition of the fauna continues to change as molecular, morphological, and integrative taxonomic studies reveal previously overlooked diversity (Mitra et al., 2021). The most recent *Fauna of India* checklist records approximately 180 species of freshwater crabs in India, comprising 110 species of Gecarcinucidae and 70 species of Potamidae, underscoring the country's importance as a Centre of freshwater crab diversity (Zoological Survey of India, 2025).

Barytelphusa cunicularis (Westwood in Sykes, 1836) is a freshwater gecarcinucid crab with a broad distribution in India and a substantial history of ecological, reproductive, and nutritional investigation. However, its taxonomy has been complicated by historical changes in generic boundaries and the use of different combinations for morphologically related taxa. Pati and Yeo (2022) substantially revised the genus *Barytelphusa*, restricted *Barytelphusa* sensu stricto to *Barytelphusa cunicularis* and *Barytelphusa inflata*, designated a neotype for *B. cunicularis*, and confirmed *Potamon* (*Potamonautes*) *jacquemonti* Rathbun, 1905 as a junior subjective synonym of *B. cunicularis*. The same revision transferred *Barytelphusa guerini* to the newly established genus *Barusa*. These changes are important when interpreting older ecological and distributional records because historical records may have been published under taxonomic combinations that are no longer accepted.

The species occurs across a broad geographic range in India, with records extending from the northern parts of the country to the southern Western Ghats. Recent taxonomic and molecular work has further emphasized the need to reassess historical distributional records because superficially similar gecarcinucid taxa may have been incorrectly identified in older collections and field surveys (Pati and Yeo, 2022). Regional studies have documented *Barytelphusa cunicularis* a variety of freshwater and semiterrestrial settings, including river systems, tributaries, streams, agricultural landscapes, and burrow-associated habitats. In Maharashtra, particularly in the Nanded and adjoining Marathwada region, the species has been the subject of studies on habitat use, burrowing behavior, reproductive biology, feeding, market utilization and nutritional composition (Padghane and Chavan 2018; Chavan et al., 2020).

Beyond its ecological importance, *Barytelphusa cunicularis* has local economic and nutritional significance. The species is collected and marketed for human consumption in parts of Maharashtra, and regional market studies have documented its sale, consumer demand, and associated livelihood activities (Padghane et al., 2016). Chavan et al. (2020) have reported substantial protein content and presence of mineral and trace-element constituents in edible tissues although the available nutritional literature remains relatively limited and methods differ substantially among studies. Balkhande and Ratnakar (2019), have investigated their exoskeleton as a source of chitin and chitosan, demonstrating the potential of crab shell material for value-added applications. Such findings further strengthen the commercial relevance of the species beyond direct consumption. However, actual medicinal efficacy and industrial potential necessitate further biochemical, toxicological, and application-oriented studies.

Older taxonomic revisions, regional habitat surveys, reproductive studies, laboratory experiments, and preliminary biochemical investigations presented a rather fragmented account of *Barytelphusa cunicularis*. The recent taxonomic revision of *Barytelphusa*, while substantially clarifying the species' identity and historical nomenclature, has also highlighted the importance of re-evaluating older biological and distributional records under the current taxonomy (Pati and Yeo, 2022). Although species-specific studies have provided important information on habitat use, reproduction and biochemical characteristics, including evidence for seasonal reproductive activity and the possibility of reproduction extending beyond the principal breeding period (Diwan and Nagabhushanam, 1974; Sherkhane, 2022), quantitative data on population abundance and dynamics, natural feeding ecology, geographic variation in life-history traits, nutritional variability among populations, contaminant accumulation, and sustainable exploitation are scarce. Pati and Yeo, 2022 have demonstrated the broad environmental and geographic range occupied by *B. cunicularis* and emphasized the need to understand the effect of local environmental conditions on variation at the population level.

This review aims to analyze the available evidence on the taxonomy, distribution, habitat, behavior, feeding biology, reproductive biology, nutritional and biochemical characteristics, and ecological and socioeconomic significance of *B. cunicularis*. Emphasis is placed on distinguishing species-specific evidence from conclusions derived from broader freshwater crab literature, evaluating the methodological limitations of existing studies, and identifying research priorities needed to improve the understanding, conservation, and sustainable utilization of this freshwater crab.

2. Taxonomy and Distribution

Barytelphusa cunicularis (Westwood in Sykes, 1836) was originally described as *Thelphusa cunicularis* from the Deccan region of India. The species has a complex nomenclatural history, with several historically assigned taxa subsequently reassessed through taxonomic revisions. Pati and Yeo (2022) examined name-bearing type material and designated a neotype for *Thelphusa cunicularis* to stabilize the application of the name. They also demonstrated that *Potamon* (*Potamonautes*)

jacquemonti Rathbun, 1905 is a junior subjective synonym of *Barytelphusa cunicularis*. The species is currently placed in the family Gecarcinucidae.

The comprehensive revision of *Barytelphusa* substantially altered the historical composition of the genus. *Barytelphusa* sensu stricto is now restricted to two species: *Barytelphusa cunicularis* and *Barytelphusa inflata*. The revision further established the genus *Barusa* for taxa previously placed in *Barytelphusa*, including *Barusa guerini* (H. Milne Edwards, 1853), and reassigned several other nominal taxa to their appropriate genera or synonymies. These changes are particularly important for interpreting older ecological and distributional literature because records published under historical generic combinations may not correspond to currently accepted species identities (Pati and Yeo, 2022). The current Indian checklist also recognizes *Barytelphusa cunicularis* and *B. inflata* as separate species and *Barusa guerini* as a distinct taxon (Pati, 2025).

Barytelphusa cunicularis is widely distributed in India, especially across the Western Ghats and adjoining regions of the Deccan Plateau. Turner et al., 2025, have confirmed that the range of *B. cunicularis* extends from southern Kerala (about 8.51° N) to Uttarakhand (29.95° N). During this study thriving populations of the species were observed in the freshwater habitats of this expanse from low elevations through the foothills and slopes of the Western Ghats onto the Deccan Plateau.

The species has been reported from numerous Indian states, including Andhra Pradesh, Chhattisgarh, Goa, Gujarat, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Puducherry, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand, and West Bengal (Pati, 2025).

Maharashtra represents one of the better-studied regions for *B. cunicularis*. The species has been recorded from multiple freshwater systems and localities within the state, including areas associated with the Godavari basin. Regional field studies in the Nanded region documented the species in the tributaries of the Godavari River and recorded burrows in river beds, particularly in areas containing boulders and rocks (Padghane and Chavan, 2018). A separate habitat study in the same region reported the occurrence of burrows in boulder- and rock-associated habitats and quantified burrow frequencies at several sites (Padghane and Kajalkar, 2021).

The recent taxonomic revision has important implications for the interpretation of historical distribution records. Older records identified as *Barytelphusa guerini* should be reassessed because this species is now assigned to the separate genus *Barusa*. Consequently, historical occurrence records based solely on older generic combinations cannot automatically be incorporated into present-day distribution maps for *Barytelphusa cunicularis* (Pati and Yeo, 2022).

Although the geographic distribution of *Barytelphusa cunicularis* is relatively well documented, there are ambiguities vis-à-vis population abundance, population connectivity, habitat-specific occupancy, and geographic variation. Turner et al. (2025) reported the presence of considerable genetic structuring among sampled populations. They found that the genetic distances are more consistent with intraspecific variation rather than interspecific variation. This study also demonstrated that there were significant seasonal and population-wise differences in physiological responses. The study also emphasized the importance of local environmental

conditions on such responses for the assessment of future vulnerabilities of geographically separated populations.

In view of these studies, it is imperative that future studies on the distribution of *B. cunicularis* should use molecular identification tools to augment standardized field surveys, particularly in regions where the species occurs alongside morphologically similar gecarcinucid species. Such integrative study would pave the way for establishing genuine range boundaries and freeing the data from historical identification errors thereby improving the understanding of population structure, habitat associations and regional ecological differentiation.

3. Habitat and Burrowing Behavior

Barytelphusa cunicularis occupies a range of aquatic and semi-terrestrial habitats like lakes, reservoirs, irrigation systems, paddy-field environments, rivers and streams (Alcock, 1909; Bahir and Yeo, 2007). The species has been found to frequent burrows and sheltered spaces associated with riverbanks, rocky substrates, and boulder-rich areas. Padghane and Kajalkar (2021) have reported presence of burrows in the Godavari River basin, predominantly from areas containing boulders and rocks. This study indicates an association of the species with relatively stable and structurally complex substrates.

Several studies have been carried out on burrow frequencies of *Barytelphusa cunicularis*. Padghane and Chavan (2018) reported mean frequencies of 9.35 ± 0.40 and 6.92 ± 0.41 burrows m^{-2} in the Asna and Lendi tributaries, respectively while Padghane and Kajalkar (2021) during their investigation at study sites reported burrow frequencies of approximately 8.0 and 17.2 burrows m^{-2} , thus establishing that *Barytelphusa cunicularis* can occur locally with high densities and that its burrowing activity may represent a conspicuous component of suitable riverine habitats.

Burrows protect individuals from predators and environmental fluctuations, including changes in temperature, moisture and water level by offering shelter (Yeo et al., 2008). Such functions are consistent with the ecology of semiterrestrial freshwater crabs more generally, in which burrows may provide refuge during periods of drought, flooding, elevated temperature and reduced surface water availability (Cumberlidge et al., 2009). However, species-specific experimental evidence relating burrow architecture to substrate characteristics, water availability, flow regime, and microclimate remains limited.

The apparent association of *Barytelphusa cunicularis* burrows with rocky and boulder-rich habitats suggests that substrate structure may be an important determinant of burrow occurrence (Padghane and Kajalkar, 2021). Similar relationships between substrate composition, bank stability, and burrow occurrence have been reported in other freshwater and semiterrestrial crab systems, although these patterns may vary among species and habitats (Cumberlidge et al., 2009). However, the current literature is insufficient to confirm this being an active habitat preference. These relationships could also be a result of greater burrow persistence and detectability in structurally stable substrates. Further studies that analyze the relationship between burrow occurrence and parameters such as substrate type,

moisture, temperature, and burrow characteristics under controlled conditions would improve our understanding of habitat selection and burrowing ecology in this species.

4. Feeding Biology

The feeding biology of *Barytelphusa cunicularis* has received little attention till date and the available data are primarily sourced from laboratory feeding experiments and observations of feed acceptance. In a captive feeding experiment, trash fish, clams, and a combination of both were evaluated as feed sources. Vartak et al. (2013) found that a combination of fish and clams resulted in the highest feed acceptance ($92.76 \pm 2.26\%$) and specific growth rate ($0.92 \pm 0.20\%$), and produced greater growth than the individual feed treatments. These findings indicate that *Barytelphusa cunicularis* can utilize animal-derived food resources and may exhibit dietary flexibility under captive conditions. Since captive feeding trials may be influenced by food presentation, prey accessibility, stocking density, and the absence of natural alternatives, it is inadvisable to interpret these results as a complete description of the species' natural diet.

There are limited studies that assess the relative contributions of animal and plant material to the diet of *B. cunicularis* outside captivity. Freshwater crabs are usually considered opportunistic feeders with a natural diet ranging from animal prey, carrion, plant material, algae, and detritus, depending on habitat and resource availability (Yeo et al., 2008; Cumberlidge et al., 2011). However, classifying a species as either carnivorous or omnivorous should ideally be based on direct field evidence, including gut-content analysis, stable-isotope analysis or controlled prey-selection experiments. The consumption of molluscan material by *Barytelphusa cunicularis* appears to be plausible because during captive feeding experiments of Vartak et al. (2013), clam tissue was readily accepted. However, such a study under controlled laboratory conditions cannot be considered as conclusive evidence for preferential consumption of molluscs in the wild in view of limited field observations of feeding by *Barytelphusa cunicularis*. Thus, considerable gaps exist in our understanding of the feeding ecology of this species. It is therefore advisable to consider *Barytelphusa cunicularis* as a potentially flexible or opportunistic feeder instead of classifying it definitively as either carnivorous or omnivorous. Further comparative studies on gut contents across seasons, habitats, sex and size classes as well as quantitative studies on availability and selection of prey need to be carried out. Stable-isotope analysis could help estimate the relative importance of animal and plant-derived resources over longer periods, whereas DNA metabarcoding of gut or fecal material could improve the detection of soft-bodied prey and highly digested food items (Pompanon et al., 2012; Valentini et al., 2009). Controlled prey-choice experiments need to be conducted to distinguish between active dietary preference and passive consumption. Future research should investigate ontogenetic dietary shifts, seasonal variation in feeding, habitat-specific resource use and the ability of *Barytelphusa cunicularis* to digest hard-shelled prey.

5. Reproductive Biology

Barytelphusa cunicularis is dioecious with marked seasonal reproductive activity. Diwan and Nagabhushanam (1974) reported that gonadal ripening began during

March with most individuals attaining gonadal maturity by June. Spawning occurred predominantly from June to September. The maximum gonadal development recorded during June–September indicates a strong association between reproductive activity and the monsoon period.

However, there are more recent studies that support a broader breeding season in *Barytelphusa cunicularis*. Sherkhane (2022) reported that *B. cunicularis* breeds throughout the year. The study reported a high proportion of mature females during June and July, when the ovarian index was also highest pointing to the possibility of reproduction occurring outside the principal seasonal peak. Reports of sex ratio and the frequency of ovigerous females also vary among studies. Although the increased occurrence of mature or ovigerous females has been reported during the monsoon months, robust population-level estimates of seasonal sex-ratio variation remain limited. Consequently, a generalized female-biased breeding-season sex ratio should not be presented as an established species-wide pattern.

Size at sexual maturity has been reported to differ between sexes. Diwan (1973) reported sexual maturity at approximately 40 mm carapace width in males and 44 mm in females. However, size at maturity may vary among populations under varying environmental conditions.

Neuroendocrine regulation has also been observed in *Barytelphusa cunicularis*. Nagabhushanam and Diwan (1973; 1974) examined the effects of eyestalk removal on physiological and reproductive processes. They found that the eyestalk endocrine system plays a role in regulating metabolism and reproduction. However, it is difficult to assess the magnitude or timing of endocrine regulation in natural conditions on the basis of these laboratory studies.

6. Nutritional and Biochemical Composition

Proximate composition studies on the nutritional value of *Barytelphusa cunicularis* meat have reported approximately 78.7% moisture, 16.7% protein, 1.9% ash, and low lipid content in muscles (Chavan et al., 2020). These values indicate a lean, high-protein tissue with high moisture content. It shows low fat and low cholesterol content, but with the presence of polyunsaturated fatty acids, including omega-3 fatty acids. These characteristics suggest potential nutritional value, although their significance for human health requires assessment within a broader dietary and food-safety context.

Chavan et al. (2020) reported that muscle tissue from *B. cunicularis* showed comparatively high concentrations of the macronutrient minerals—potassium (K), sodium (Na), calcium (Ca), and magnesium (Mg)—with smaller quantities of iron. They found low amounts of elements (Zn, Sr, Mn, Cu) with zinc (Zn) and strontium (Sr) emerging as the most abundant microelements.

Available data indicate that protein, carbohydrate, free amino acids, and polyunsaturated fatty-acid proportions may be higher in males than in females (Sudha Devi 2012). Cholesterol levels for *Barytelphusa cunicularis* meat were found to be lower than those reported for the marine crab species. Diwan and Nagabhushanam (1974) studied seasonal changes in gonadal maturation. They found that reproductive

condition may influence biochemical composition and nutrient allocation in this species.

The biochemical composition of *Barytelphusa cunicularis* meat is broadly comparable to brackish water and marine crabs across protein, carbohydrate, free amino acid, lipid, and moisture parameters, while being lower in saturated fatty acids and cholesterol. This positions a widely available and inexpensive freshwater species as nutritionally comparable to commercially marketed marine crabs—a point of direct relevance to food security and local livelihoods (Sudha Devi 2012).

Discussion and critical appraisal

The principal limitation of the current evidence base is its narrowness. Proximate data come from a handful of studies often differing in sample location, season, tissue type (claw vs. body meat), and analytical units, which complicates direct comparison (Chavan et al., 2020; Sudha Devi 2012). In particular, the influence of habitat, season, diet, and reproductive status on proximate composition has not been systematically disentangled, and no work to date (to the best of the information reviewed here) has integrated compositional data with a full fatty acid profile or with an assessment of contaminant (heavy metal) burdens for *Barytelphusa cunicularis* specifically. Toxicological studies on *Barytelphusa cunicularis* have investigated physiological and histological effects of metal exposure. But analysis of heavy-metal residues in the edible muscle in wild populations of *Barytelphusa cunicularis* are not evident in peer-reviewed literature (Varghese et al., 1992; Sakhare and Kamble, 2015).

7. Ecological, Economic, and Cultural Significance

Barytelphusa cunicularis also holds ecological and local significance in several respects. Due to its burrowing habit, *B. cunicularis* may contribute to sediment disturbance and nutrient redistribution in its habitats, although species-specific ecosystem-level measurements of these functions remain lacking (Cumberlidge and Ng, 2009; Yeo et al., 2008). In parts of India, freshwater crabs—including this species—are consumed as an inexpensive protein source, and regional ethnobiological reports document medicinal uses of freshwater crabs for ailments such as asthma, cough/fever, and joint pain; these claims are primarily at the level of “freshwater crab” generally and should not be attributed to *Barytelphusa cunicularis* alone without species-specific confirmation (Rout et al. 2024)

The consistent abundance of *Barytelphusa cunicularis* in the Godavari basin and across Maharashtra raises its profile as a candidate for small-scale, low-input harvest aimed at food security, if sustainability criteria are met (Padghane and Kajalkar, 2021). However, the absence of data on growth rates, recruitment, and harvest resilience means that any such initiative currently lacks an evidential basis (Cumberlidge and Ng, 2009).

8. Research Gaps and Future Directions

Synthesis of the reviewed literature highlights several specific, well-defined gaps:

1. Distributional data are coarse. Although the species' broad range in India is known, fine-scale abundance, occupancy, and the environmental correlates of both are

available for only a few river systems (Pati and Yeo, 2022; Padghane and Kajalkar, 2021).

2. Taxonomic boundaries need field-level application. Following the revision of Pati and Yeo (2022), survey and nutritional studies must confirm species identity (especially *Barytelphusa cunicularis* vs. *Barusa guerini*) to avoid confounding already-reported data (Pati and Yeo, 2022).

3. Dietary ecology is under-quantified. Standardized gut content and stable isotope studies, including seasonal and ontogenetic variations, are needed to resolve the carnivorous–omnivorous question (Yeo et al., 2008; Cumberlidge and Ng, 2009).

4. Life-history parameters are unknown. Growth rates, longevity, fecundity, and recruitment for wild populations have not been measured, limiting any sustainability assessment (Cumberlidge and Ng, 2009).

5. Nutritional data are too sparse and heterogeneous. Interstudy comparability is undermined by inconsistent methods, tissue types, seasons, and units; a standardized, seasonally stratified proximate and fatty acid characterization is required (Sudha Devi 2012; Chavan et al., 2020).

6. Food safety data are absent. Heavy metal and other contaminant burdens specific to *Barytelphusa cunicularis* have not been established, a prerequisite for recommending consumption; experimental exposure studies exist for this species, but verified edible-tissue residue data are lacking in the sources reviewed here (Varghese et al., 1992; Sakhare and Kamble, 2015).

7. Very few comparative and experimental studies have been reported on neuroendocrine control of reproduction in *Barytelphusa cunicularis*. Only one ablation study has explored this aspect while the interaction of temperature, moisture, and monsoon variability with the species' biology vis-à-vis projected climate change remains largely unexplored (Anne Rebecca et al., 2024; Cumberlidge and Ng, 2009).

A priority for future work is a coordinated, standardized assessment combining taxonomy, population ecology, reproductive and feeding biology. Apart from these, nutritional and contaminant profiling across the species' range, particularly in the Western Ghats and Godavari basin, where substantial field and ecological information is available are promising themes for further research. (Pati and Yeo, 2022)

9. Conclusion

Barytelphusa cunicularis is a widely distributed and ecologically successful freshwater crab. It shows great nutritional potential but has hitherto received little scientific attention as compared to its marine relatives (Pati and Yeo, 2022; Yeo et al., 2008). It appears to be a nocturnal, burrowing species apparently showing flexible or opportunistic feeding behavior (Sudha Devi 2012; Chavan et al., 2020). The higher protein and polyunsaturated fatty acid content recorded in males, together with seasonal mobilization of muscle reserves into gonads, indicate that sex and reproductive state are important determinants of nutritional value (Sudha Devi 2012; Diwan and Nagabhushanam, 1974). Its recent taxonomic clarification, together with frequent sympatry and historical confusion with *Barusa guerini*, underscores the need for species-level rigor in future work (Pati and Yeo, 2022). The chief constraint on drawing firm inferences is the limited owing to heterogeneous nature of existing

literature. Standardized, integrative studies addressing the distributional, life-history, dietary, and food-safety dimensions identified here would substantially strengthen the scientific basis for the sustainable use of this species and for its wider recognition as a locally valuable food resource (Cumberlidge and Ng, 2009; Rout et al. 2024; Padghane and Kajalkar, 2021).

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