Presently brachyuran crabs belonging to family Portunidae and Genus *Maydellithelphusa masoniana* and *Himalayapotamon emphysetum* have been studied with an aim to generate formation on their life cycle aspects and feeding ecology. To achieve the said objectives, following parameters pertaining to their biology have been thoroughly investigated:

1. Sexual dimorphism
2. Sex ratio
3. Size frequency distribution
4. Size at maturity
5. Heterochely and handedness
6. Gonadosomatic index
7. Condition factor and Relative condition factor
8. Fecundity
9. Moulting
10. Effect of physico-chemical parameters on abundance of crabs (C.P.U.E)
11. Feeding ecology
1. **Sexual dimorphism:** Sexes of crab, *M. masoniana* and *H. emphysetum* have been distinguished on the basis of (a) presence of wider abdomen in females compared to males at all stages of development (b) presence of 2 pairs of gonopods in males and 4 pairs of pleopods in females. Heterochelous chela, since, equally prevalent in both the sexes of under studied species, therefore, do not appear to be a sexually dimorphic character.

2. **Sex ratio:** During the present studies overall sex ratio was observed to be 1:1.08 and 1:0.94 in *M. masoniana* and *H. emphysetum* respectively thereby exhibiting slight deviation from 1:1. It simply implies that crab population of stream Ghomansan tends to be female biased while in Jhajjar stream it is male biased. In both the species, sex ratio was never found to be constant but fluctuated during the study period. In *M. masoniana*, sex ratio though recorded to be female biased, yet during June-July and December-January, (i.e. breeding season) male out number females, that may be due to the fact that after mating, females usually hide in burrows for the protection of their brood, thereby resulting their absence in catch. Seemingly in *H. emphysetum*, sex ratio although was observed to be male biased but females surpass males in the months of May and October. *H. emphysetum* though was a continuous breeder but breeding activities were recorded to be least during these months, as the females usually leave burrow and come out for feeding purpose thereby leading to a marked change in the sex ratio. Besides monthly variations, sex ratio was recorded to vary within carapace width as smaller class size was found to be female biased where as in larger size class, males outnumbered females. The variation in sex ratio within carapace width is attributed to slow growth rate of females as compared to their male counterpart.

3. **Size frequency distribution:** Studies on size frequency distribution revealed that *M. masoniana* exhibit sex wise variations in size. Males attain comparatively larger size than females in *M. masoniana*, while in *H. emphysetum*, both the sexes attain equal size. In *M. masoniana*, modal class was recorded to be at 5-6 cm CW in males whereas 4-5 cm CW in case of females. In *H. emphysetum* on other hand, modal class size recorded to be at 4-5 cm CW in both the sexes. Variations in size
of sexes in *M. masoniana* may be because: (a) females spend most of their energy for reproductive process (maturation of gonads, incubation of eggs and protection of brood) and hence may tend to mature with inferior size than males who on the other hand use energy principally for somatic growth (b) larger size in males appear to have an adaptative advantage to win intraspecific fights and provide opportunity to these large size mate with fairly large number of sexually mature females (c) high water level and burrow habit protect the crab from the predatory birds and thereby provide an opportunity to gain larger size. In *H. emphysetum*, though above mentioned causes (a) and (b) are equally applicable, but low level of water and absence of burrows do not warrant the size increase as it might attract the predators. Moreover, the role of genetic factors as a governing parameter cannot be ruled out.

It was also observed that juveniles of *M. masoniana* were rarely spotted and that too in the months of ending June-July (during first breeding period) and December-January (during second breeding period) whereas in *H. emphysetum* they were present almost every month during the study period.

4. **Size at maturity:** Presently, two types of maturity have been recorded viz. (i) morphological maturity and (ii) physiological maturity.

Morphological maturity was based on the class size at which chela in males and abdomen in females exhibit allometric growth with respect to carapace width (CW). Physiological maturity on the other hand was determined based on size of gonads.

In *M. masoniana*, females although were observed to acquire morphological maturity at smaller size (3-4 cm CW) but very interestingly remain sexually immature and attain physiological maturity at same class size as that of male crabs i.e. 4-5cm CW. To make it clear, it may be added that females although attain morphological maturity at earlier stage (3-4cm CW compared to males (4-5cm CW) but still do not have ovaries competent enough to produce viable eggs which they, however, attain at size>4-5cm CW. It is at this size that ovaries start
producing eggs for fertilization and hence qualify now to have attained physiological maturity.

In male crabs both morphological and physiological maturity was observed to coincide at class size 4-5 cm CW. It is at this very size only males are competent to mate as well as acquire ability to produce sperms. Thus unlike females where physiological and morphological maturity is attained at different sizes, in males both types of maturity coincide at same class size i.e. 4-5 cm CW.

In *H. emphysetum*, female attain functional maturity (morphological and gonadal maturity) at the same class size (3-4 cm CW). In males, however, functional maturity is recorded at comparatively larger class size (4-5 cm CW).

5. **Heterochela and Handedness:** Presently heterochela is observed to be prominent in both the sexes but in general the size of larger chela in female was comparatively smaller than males in all stages of development. This may be attributed to the fact that in males, chela has to perform a much significant function and therefore more energy is incurred towards claw growth so that it can gain higher dimension that will help to defend territory, exhibit sexual signaling, win intraspecific fights whereas in females it usually helps in brood protection only. Further in under studies crabs, only 27% & 28% of population showed left handedness while 72% & 65% exhibited right handedness in case of males of *M. masoniana* and *H. emphysetum* respectively. Seemingly, in females, 29% & 24% were left handeded whereas 70% & 65% exhibited right handedness in *M. masoniana* and *H. emphysetum* respectively. Seemingly, in females, 29% & 24% were left handeded whereas 70% & 65% exhibited right handedness in *M. masoniana* and *H. emphysetum* respectively. Thus, both the under studied species exhibit tendency towards right handedness compared to left handedness irrespective of sexes. Less number of crabs having left handedness as compared to right handedness is probably due to the fact that following the loss of larger chela, smaller chela attain higher dimension. The regenerated chela, however, reveal limited growth potential and restricts to a comparatively smaller size.
6. **Gonadosomatic index (GSI):** In *M. masoniana*, maximum value of GSI in males was observed in the month of June (0.48±0.13 & 0.49±0.11) and December (0.45±0.12 & 0.46±0.20) while minimum in August (0.38±0.20 & 0.44±0.14) and March (0.41±0.20 & 0.40±0.20) during 1st and 2nd year of study period respectively. Similar to male, maximum GSI in female crabs was recorded in June (0.75±0.13 & 0.79±0.18) and December (0.75±0.16 & 0.69±0.24) while minimum in August (0.37±0.21 & 0.42±0.13) and March (0.49±0.20 & 0.48±0.24) during 1st and 2nd year of study period respectively. As Compared to *M. masoniana*, maximum value of GSI in males of *H. emphysetum* was recorded in the month of June (0.44±0.20 & 0.42±0.13) while minimum in December (0.30±0.10 & 0.35±0.11) during the 1st and 2nd year of investigations respectively. In females on other hand, maximum GSI was noted in June (0.74±0.21 & 0.86±0.12) and minimum in January (0.64±0.21) and March (0.70±0.20) during 1st and 2nd year of investigations respectively.

Further, males of both the species exhibit variations with respect to size only. In females, on the other hand gonads exhibit well marked variations with respect to size as well as season. GSI in mature female of *M. masoniana* follow an increasing trend from August to December, which thereafter decrease with minimum value in March. This is again followed by an increase with a marked peak in June. GSI afterwards, undergo decrease in its value with its minimum in August. Thus, there is a clear cut increase in value of GSI with approach of breeding season which marks a remarkable decline after that. In *H. emphysetum*, on the other hand no such peculiar trend was recorded.

7. **Condition and relative condition factor:** Mean condition factor (K) in *M. masoniana* varied from 0.0370±0.0012 to 0.066±0.0026 in males and from 0.0368±0.0032 to 0.0583±0.0025 in females whereas in *H. emphysetum* the condition factor varied from 0.0324±0.0028 to 0.0602±0.0022 in males and between 0.0314±0.0018 and 0.0536±0.0023 in females. The relative condition factor (Kn) in *M. masoniana* varied from 0.78±0.10 to 1.08±0.20 in males and from 0.64±0.12 to 0.98±0.16 in females while in *H. emphysetum* it varied from
0.62±0.14 to 1.02±0.14 in males from 0.58±12 to 0.92±0.26 in females. Thus overall condition and relative condition factor in males of both the species were slightly higher than that of females.

The condition factors and relative condition factor in both the sexes of *M. masoniana* were slightly higher than that of *H. emphysetum* thereby indicating interspecific difference. Males of both the species show a continuous increase of K and Kn values with increase in size, however, a sudden increase has been recorded at 4-5 cm CW. In females on the other hand, K and Kn follow increasing trend upto 4-5cm CW, with a sudden increase at 3-4 cm CW. Such an abrupt increase in values of K and Kn at 4-5 cm CW and 3-4 cm CW of males as well females of both the species respectively correspond to the stage of their morphological maturity. Condition factor provide information regarding well being of animal. Further any unusual rise in condition as well as relative condition factor value represent the stage where allometric type of growth has been taken place thereby help to authenticate the size of pubertal molt (i.e. size at which allometric growth take place).

8. **Fecundity:** Fecundity was observed to vary from 430±36 eggs at 4.0cm CW, 59 g Weight and 3.8 cm Ab.W to 910±28 at 5.7 cm CW, 97 g weight and 4.9 cm Ab.W with average fecundity 650±171 in *M. masoniana*. In *H. emphysetum* on other hand, fecundity was recorded to vary from 98±26 eggs at 3.4 cm CW, 33g W and 2.9 cm Ab.W to 351±158 at 4.9 cm CW, 89 g weight and 4 cm Ab.W., with average fecundity being 365±160 eggs. Variation in fecundity is based on the fact that female of *M. masoniana* comparatively hold larger size than *H. emphysetum*. Larger size females have wider abdomen and therefore, have more capacity to hold the eggs as compared to smaller size crab. Further *H. emphysetum* being continuous breeder save less energy for production of eggs, as gonads of this species start gaining size immediately after spawning, which however, was not so in case *M. masoniana* where female got enough time (approximately 4-5 months) for next breeding.
Fecundity variation within carapace width might be an age related feature, representing the number of times, a female is bearing eggs and ofcourse the geographical isolation is another important factor that cannot be ruled out. Correlation between fecundity vs CW, Ab.W as well as Weight was observed to be positive and significant in both the species. Though number of mature females recorded was quite high in *M. masoniana* (biannual breeder) as well as in *H. emphysetum* (continuous breeder), yet the number of ovigerous females were quite less in both the species.

9. **Moulting:** The different morphological changes that took place in under studied crabs at the moulting were:

   (a) The exoskeleton start to acquire light yellow colour.

   (b) Appearance of double line in pereiopods resulted due to separation of old cuticle from new one, formed beneath it.

   (c) The old carapace becomes completely light yellow in colour and broke along the postero-lateral margin of the dorsal side, anterolateral border of the venral side and posterior border of the chelipeds and legs.

   (d) At last new pre-exuvial soft layer is formed below the old carapace and the crabs of this stage came out from the old case leaving the skeleton almost intact.

The body of newly moulted crab exhibited remarkable change with respect to its level of hardening; being very soft in the beginning and later hardened with passage of time. It has been recorded that exoskeleton of crabs undergo 40% of hardening at 30-40 hours, 50-55% at 50-70 hours and 70-80% hardened at 80-100 hours, and completely hardened after 96 hours.

As molting took place within 5-8 days after the start of experiment, it can be presumed therefore, that the crabs were already in advance pre molt stage and molted within few days after their arrival.
10. **Effect of Physico-chemical parameters on Catch per unit effort (C.P.U.E.):**
The C.P.U.E. data revealed that crab population abundance in both the species never remained constant but exhibit fluctuation throughout study period. In *M. masoniana* abundance of crab population was found to vary with respect to stations, being maximum at station I (undisturbed) somewhat less at station II (moderately disturbed) and absent at station III (highly disturbed), whereas in case of *H. emphysatum*, comparatively far less number of crabs have been recorded throughout the study period and that too, from station II only.

Due to sparse presence of *H. emphysatum* in Jhajjar stream, no correlation between crab abundance and physico-chemical parameters could be drawn, however, presently due to high CPUE value, correlation between crab abundance and physico-chemical parameters was estimated in *M. masoniana* only. It has been observed that crabs exhibited positive correlation with respect to DO, Ca\(^{2+}\), Mg\(^{2+}\), HCO\(_3\)\(^{-}\)-Depth, pH, Temperature and Cl\(^{-}\) depicted negative correlation.

Increase in physical anthropogenic disturbances (at station II) was observed to markedly decrease crab abundance mainly because of alterations of physico-chemical parameters and habitat destruction. Moreover at station III where household sewage and run off from surrounding area finds entry besides being the dumping site of waste was observed to ultimately result in marked deterioration of its physico-chemical parameters. Thus, it appear, presently this might have resulted in evacuating of this station by crabs.

11. **Feeding ecology:** The diet composition and the feeding activity of both the crabs were evaluated through the examination of the stomach contents and their degree of emptiness. The feeding ecology of studied crabs were characterized for both the sexes as well as individuals of different class size. Among 388 (226 Maydelliathelphusa and 162 Hiamalaypotamon) different stomach examined, it was recorded that the studied crabs predominantly consumed algae, insects larvae (chirnomous), earthworm, molluscs, crustaceans such as prawn & crabs and fishes. In adults and sub-adults the dominant food items found to comprise of almost all type of animal matter. Molluscs, however, were recorded from gut
content of *M. masoniana* whereas in the gut of *H. emphysetum* their preference was least/negligible. In smaller crabs on other hand, plant matter and detritious constitute the dominant group in both the species. The stomach content indicates that its trophic role in the community is omnivorous and detritivorous.

Further order of preference of food observed to be Detritius>Unidentified matter>Arthropods>Molluscs>Annelids>Fishes in *M. masoniana*. In *H. emphysetum* on other hand, it was recorded to be Detritius>Unidentified matter Annelids>Arthropods>Molluscs>Algae. The variation in comparatively least preference of molluscs as well as arthropods in *H. emphysetum* as compared to *M. masoniana* might be attributed to the fact that chela of this species was unable to exert sufficient force so as to break the shell of molluscs or exoskeleton of larger sized crustaceans. Based on feeding ecology, under studied crabs can be considered as omnivorous and detritivorous.