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# SURVIVAL AND DIVERSITY OF NATIVE AND INTRODUCED SNAILS IN AN URBANIZING CITY IN TURKEY

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**Summary**

A 7 year term survey of gastropod taxa in Kastamonu has been carried on between 2002 and 2008. Kastamonu is a small but, for the last decade, rapidly urbanizing city due to housing. This involves transformation of pristine habitats, also destruction of the traditional urban fabric. Construction pits and poor landscaping generally wipe out the natural ground cover thus vegetation and hiding places of native gastropods, resulting in patchiness and consequences relating to it.

Results of study compiled from presence-absence data through random collections, however, show that adaptive taxa can still survive in presence of small habitat patches. Alien species are currently found almost exclusively in newly transformed areas where native taxa very rarely coexist. Previously transformed areas (gardens, parks), in contrast, are occupied by native and translocated native taxa both. Although resulting in the survival of many native taxa, long-term succession leads to extinctions of open land (thermophilic) species. In further development of the city, planned changes are needed with respect to conserve natural components of urban biome.

KEY WORDS: Kastamonu, land snails, alien species, traditional urban fabric

## Introduction

Land snails are known to be found surprisingly wide range of habitats, from deserts to remote tropic islets. Vast majority of them are bound to calcareous outcrops (and environs), while some may be found in other habitat types as well as artificial ones. They can survive small habitat changes (like seasonal drought, flood, or wildfires), ironically, they may be susceptible to major changes like habitat destruction and climate change due to habitat specialization.

Building cities mostly involves fast-paced restoring or filling up of spaces or manipulation of untouched areas. Unplanned development results in loss of cultural, natural and scientific values. Province Kastamonu (North-Central Turkey) has been emigrant in the last century due to economic reasons, although 8$^{th}$ most populous one in 1927. Although this negative trend continues, lately the population of Kastamonu city has remarkably increased partly due to migration from rural areas. In last two decades, construction projects gained speed with housing estates established in edges of the city, which was then followed by transformation of various patches in the

city. Therefore this study was performed to determine present status of land snail diversity of the city and to elucidate possible effects (or future effects) of modern and traditional urbanization processes according to info gathered from a 7-year survey.

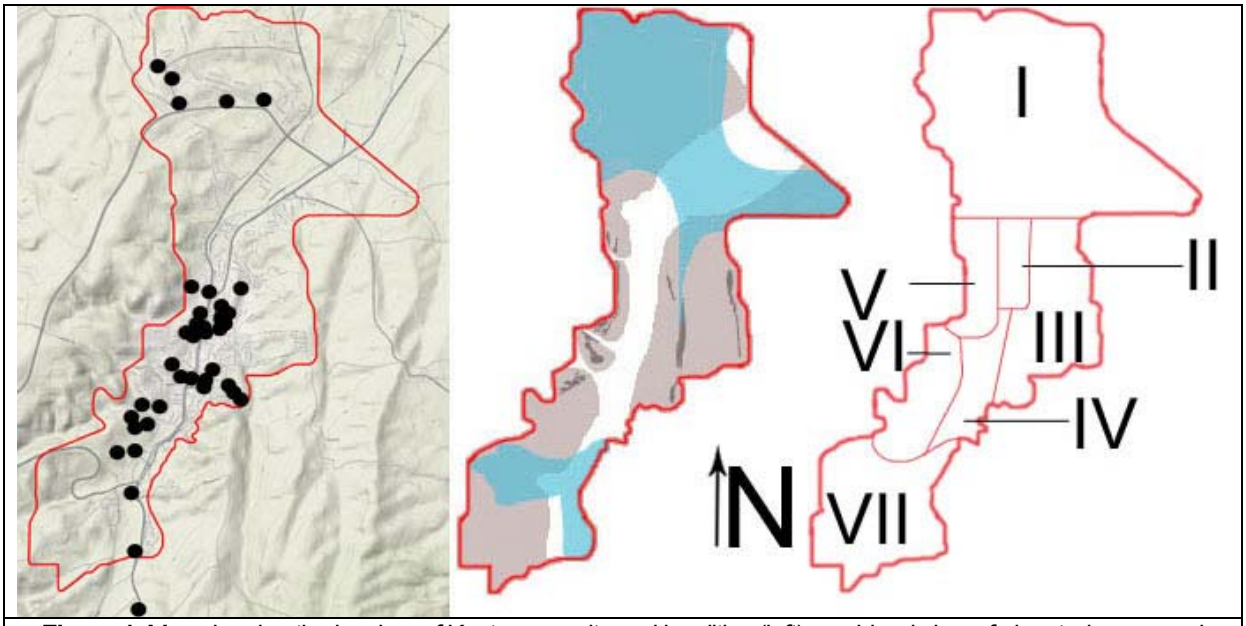



**Figure 1.** Map showing the borders of Kastamonu city and localities (left) combined view of elevated areas and new settlements (center), and sections I-VII (right): circles-localities, red-approximate borders, light brown-elevated areas, dark brown-steep hills, and blue-newly established settlement areas.

**Study area**

Kastamonu city, the administrative center of the Province Kastamonu, is located in the middle of a low plateau (at 775 m alt.) surrounded by two high mountain belts from the north and south. It is situated in Euxine district of Euro-Siberian phytogeographical region and semicontinental in climate (DEMİRÖRS & KURT, 2006). First referred by the name in XI century Byzanthian scripts (EYÜPGİLLER, 1998), city was founded by Kaskas (2000 BC). As it was the capital city of a state in Ottoman Empire, it remained an important city till the disintegration.

The city lies on the terrace sets and the bottom of Karaçomak stream valley, in NNE-SSW direction, which divides the city into two. As the flat areas are very limited on the eastern bank, this side of the city is less populous.

According to their malacofaunal composition and settlement conditions, localities (n=41) can be grouped into seven: namely Kuzeykent (5), Süt Fabrikası-Sarıkaya and Kırkçeşme districts (9 and 3 respectively), city center (8), hills of the western bank (6), castle area (6), southern extension (4) (Figure 1):

a. Kuzeykent (I): This is the major housing estate project still developing, established on a broad area at 5 km N of city center and on the western bank. The

area is composed of low lying undulated hills with seldom plantations of pine, but in general with steppic open land cover.

b. Süt Fabrikası-Sarıkaya district (II): This was the NE corner of the city before new projects, which is basically a sloppy area with a narrow strip of houses. The hills covered with pine plantations have steep boulders of Eocene flysch blocks. The area which is on the eastern bank is nowadays the most favored construction site, older houses and crags are being replaced with apartment complexes.

c. Kırkçeşme district (III): This is a hilly area on the eastern bank to the south of the previous area and above the city center. The area extends eastward to Karasu valley and typically traditional urban fabric is displayed with slight recent development. Upper parts are covered with pine woods and bushes, the malacofauna being discerned by the previous one in having open land species in general.

d. City center (IV): This section extends along the bottom of the valley. The recent development is moderate and traditional structures can be observed. However, due to landscaping, the area is characterized by presence of translocated and alien species.

e. Hills of the western bank (V): The steep hills extending northwards from the of city center are penetrated by narrow valleys. The section is separated from the following one by a broad flat area (city center). Except northern edge, being adjacent to Kuzeykent, traditional style buildings are seen in lower parts. The higher parts are covered by mixed woods, and particularly to south high boulders are seen.

f. Castle area (VI): This section includes two rocky hills separated by a stream, on top of the higher hill to the southwest of city center there is an XI century castle. Generally traditional urban fabric is observed.

g. Southern extension (VII): This is another center of recent development. To south, a loose strip of houses extend more than 7 km from the city (not shown in the map). Another branch extends towards westwards.

**Material and Methods**

41 stations were surveyed between 2002 and 2008. Collections were made randomly throughout the year (1-2 sampling per site/year). Live animals were collected only when available and necessary for identification. Identifications were done using under stereomicroscope using available literature (FORCART, 1940; HAUSDORF, 1995, 1996, 2000; SCHÜTT, 2001 and 2005; WIKTOR, 1987 and 2000). The material is kept in the personal collection of the author in M. A. E. University (Burdur, Turkey).

For cluster analysis, the localities with less then 3 species recorded (n=23) were omitted and similarity index of Bray-Curtis was used via software Biodiversity Pro.

**Results**

Totally 39 taxa (species and subspecies) from 20 different families were determined from the material collected during the study period. Among these, 8 (21%)

are endemics (Table 1). Further 6 species (ca 15%) may be named as *quasiendemic*, as these are found only in a small area in Bulgaria except Turkey (See Discussion).

| | Abbr. | Endemicity | I | II | III | IV | V | VI | VII |
|---|---|---|---|---|---|---|---|---|---|
| *Cochlicopa lubrica* (MÜLLER, 1774) | CoLu | | | | | + | | + | + |
| *Lauria cylindracea* (DA COSTA 1778) | LaCy | | | + | | | | | |
| *Sphyradium doliolum* (BRUGUIERE, 1792) | SpDo | | | | | | | + | |
| *Vallonia costata* (MÜLLER, 1774) | VaCo | | | + | | | | + | + |
| *Vallonia pulchella* (MÜLLER, 1774) | VaPu | | | | + | + | | + | |
| *Pupilla triplicata* (STUDER, 1820) | PuTr | | | | | | | + | |
| *Pyramidula rupestris* (DRAPARNAUD, 1801) | PyRu | | | | | | | + | |
| *Chondrina arcadica bulgarica* NORDSIECK, 1970 | ChAr | quasiendemic | | + | | | + | + | + |
| *Truncatellina cylindrica* (FÉRUSSAC, 1807) | TrCy | | | | | | | + | + |
| *Pseudochondrula seductilis incerta* (RETOWSKI, 1883) | PsSe | ENDEMIC | | + | + | | | | + |
| *Spaniodonta diodon* (RETOWSKI, 1883) | SpDi | ENDEMIC | | + | | | + | + | |
| *Multidentula ovularis* (OLIVIER, 1801) | MuOv | quasiendemic | | + | + | + | + | + | + |
| *Merdigera obscura* (MÜLLER, 1774) | MeOb | | | + | | | + | | |
| *Zebrina detrita detrita* (MÜLLER, 1774) | ZeDe | | + | + | + | | | + | + |
| *Zebrina kindermanni kindermanni* (PFEIFFER, 1850) | ZeKi | quasiendemic | + | | + | | | | + |
| *Chondrus tournefortianus* (FÉRUSSAC, 1821) | ChTo | quasiendemic | + | + | + | | | + | |
| *Chondrus zebrula tantalus* (PFEIFFER, 1850) | ChZe | | + | + | + | | | | + |
| *Succinella oblonga* (DRAPARNAUD, 1801) | SuOb | | | | | + | | | |
| *Oxyloma elegans* (RISSO, 1826) | OxEl | | | | + | | | | |
| *Cecilioides acicula* (MÜLLER, 1774) | CeAc | | | | + | | | + | |
| *Gallandia annularis* (STUDER, 1820) | GaAn | | | | | | | | |
| *Oxychilus deilus* (BOURGUIGNAT, 1857) | OxDe | | | + | | | + | + | + |
| *Tandonia* sp | Ta | | | | | + | | | |
| *Limacus maculatus* (KALENICZENKO, 1851) | LiMa | | | | | | + | | |
| *Deroceras berytensis* (BOURGUIGNAT, 1852) | DeBe | | | + | | | + | | |
| *Deroceras reticulatum* (MÜLLER, 1774) | DeRe | | | + | | | | | |
| *Strumosa abanti alamellata* NEUBERT, 1993 | StAb | ENDEMIC | | | | | + | | |
| *Armenica laevicollis paphlagonica* NORDSIECK, 1975 | ArLa | ENDEMIC | | + | | | | + | |
| *Euxina persica* (BOETTGER, 1879) | EuPe | quasiendemic | | | | | + | + | |
| *Galeata schwerzenbachii* (PFEIFFER, 1848) | GaSc | quasiendemic | | + | | | + | | |
| *Cochlicella barbara (LINNÉ, 1758)* | CoBa | | + | | | | | | |
| *Monacha densecostulata* (RETOWSKI, 1866) | MoDe | ENDEMIC | | + | | | | | |
| *Monacha margarita* HAUSDORF, 2000 | MoMa | ENDEMIC | | + | | | | | |
| *Monacha samsunensis* (PFEIFFER, 1868) | MoSa | ENDEMIC | + | + | + | + | + | + | + |
| *Helicopsis striata* (MÜLLER, 1774) | HeSt | | + | | | | + | | + |
| *Xeropicta derbentina* (KRYNICKI 1836) | XeDe | | + | + | + | | | + | + |
| *Xeropicta krynickii* (KRYNICKI 1833) | XeKr | | + | + | | | + | | |
| *Helix lucorum* LINNÉ, 1758 | HeLe | | | + | + | + | + | + | |
| *Helix escherichi* (BOETTGER, 1898) | HeEs | ENDEMIC | + | | | | | | + |
| TOTAL | | | 10 | 21 | 12 | 7 | 14 | 19 | 14 |

**Table 1.** Land snail taxa and their distribution in various parts of the Kastamonu city (blue=western bank, pink=eastern bank, green:both)

When distributions to localities are plotted, it is seen that Section II and VI are the richest in species numbers. When a comparison of the gastropod fauna of each banks of the stream made, it is seen that there are differences between species compositions (Table 1) as 11 species (%28) are found only on the single side (see Discussion).

*Monacha samsunensis, Helix lucorum,* and *Multidentula ovularis* are the most common species respectively. Of single site species *L. cylindracea, S. doliolum, Tandonia* sp., *C. barbara* were rarest as only one specimen could be provided from each of these. *Tandonia* sp. specimen (possibly a translocated species) couldn't be identified to species level as it was a subadult.

Most species are apparently native according to their distribution in study area and their general distribution characteristics. Several species recorded as native to Turkey (See SCHÜTT, 2001 and 2005) were found exclusively or partly in artificial habitats. These are classified here as "translocated species". Alien (or introduced) species (n=3) were found in old gardens (*Deroceras reticulatum* and *Tandonia* sp.) as well as recently established ones ( *Cochlicella barbara*) (Table 2 and 3)

**Table 2.** Land snails (Gastropoda, suborder Orthurethra) in Kastamonu city and their origins

| | CoLu | LaCy | SpDo | VaCo | VaPu | PuTr | PyRu | ChAr | TrCy | PsSe | SpDi | MuOv | MeOb | ZeDe | ZeKi | ChZe | ChTo |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Native | | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Translocated | X | | | | X | | | | ? | | | X | X | | | | |
| Alien | | | | | | | | | | | | | | | | | |

**Table 3**. Land snails (Gastropoda, suborder Sigmurethra) in Kastamonu city and their origins

| | SuOb | OxEl | CeAc | OxDe | GalAn | Ta | LiMa | DeBe | DeRe | StAb | ArLa | EuPo | GaSc | CoBa | MoDe | MoMa | MoSa | HeSt | XeDe | XeKr | HeEs | HeLu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Native | X | X | X | X | X | | X | ? | | X | X | X | X | | X | X | X | X | X | | X | X |
| Translocated | | | | X | | | | | | | | | | | | | | | | X | | ? |
| Alien | | | | | | ? | | | X | | | | | X | | | | | | | | |

**Discussion**

Land snails are represented in Turkey with 707 taxa from 42 families (most belonging to order Stylommatophora, 688 taxa from 37 families). In Kastamonu city, totally 39 taxa belonging to 20 families were determined during the study. In a previous study 30 taxa were determined (KEBAPÇI, 2004), to which following species are added: *Lauria cylindracea, Merdigera obscura, Succinella oblonga, Strumosa abanti alamellata, Euxina pontica, Cochlicella barbara, Monacha densecostulata, Monacha margarita,* and *Xeropicta krynickii.*

Due to distance from the sea, the area is influenced rather by continental climate. As seen in Figure 2, families Clausiliidae, Oxychilidae, and Orculidae (mesophile fauna) are markedly poor as compared to general account. On the other hand, of thermophilic fauna, Enidae has a much higher percentage, whereas in Hygromiidae it is very similar. Several endemics (*S. diodon, M. densecostulata* and *M. margarita*) extend their ranges to coastal mountains of Kastamonu province; but the rest are originated from interior parts of Anatolia and almost all of these are xero-mesophiles. Furthermore, a number of species of Pontic origin show a typical distribution between central Black Sea coast and eastern Bulgaria. These are also mainly xero-mesophiles and apparently originated from inner Anatolia considering fossil records and generic distributions. In the view of present findings, it can be argued that the arid period in the region took place relatively long and faunal exchange between lowland organisms remained continuous (without interruption), while adaptable mesophiles survived in available pockets.

According to results of the study faunal composition of two sides of the city somewhat differ. As summarized in Figure 3, 11 species were not reported from either western or eastern side, while 4 species can only be recorded once from one side,

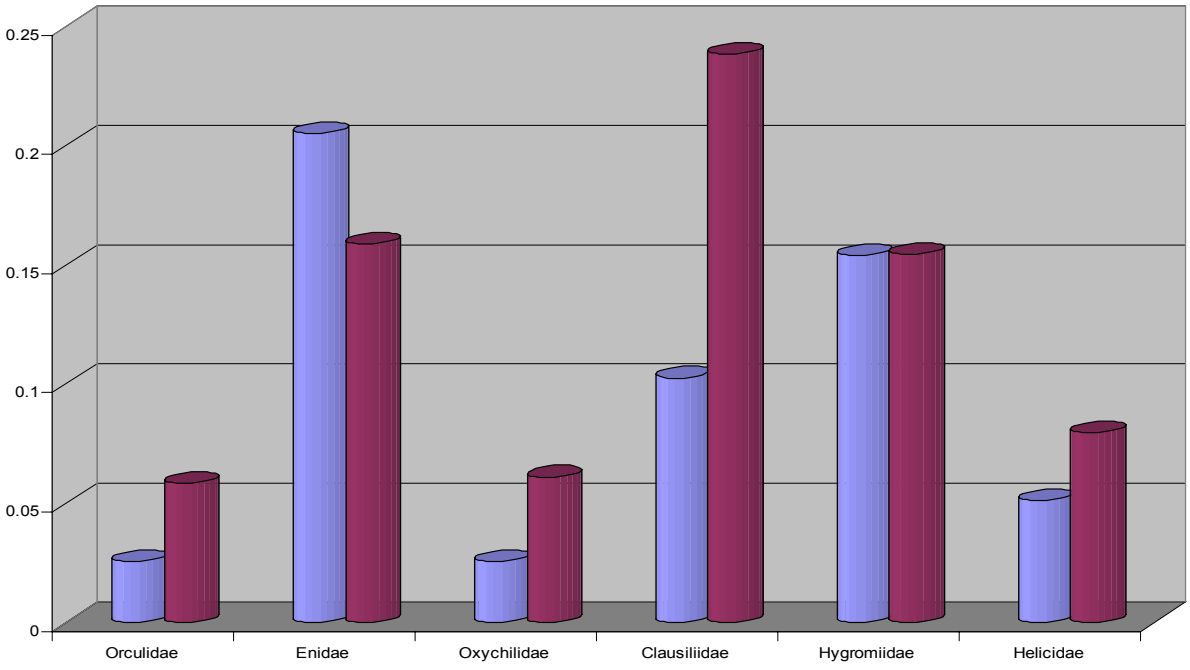



**Figure 2.** Comparison of taxa belonging to snail families in Kastamonu city and Turkey (left-Kastamonu, right Turkey)

although common on the other side. On the other hand, there are several species (circles) that are rare almost certainly due to habitat availability and may be found in the future from further localities.

A test of similarity between localities (with more than 2 species) is provided with a cluster analysis (Figure 4):

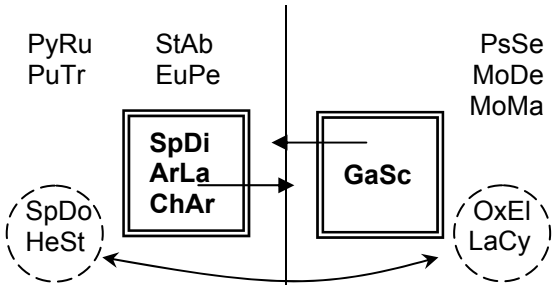
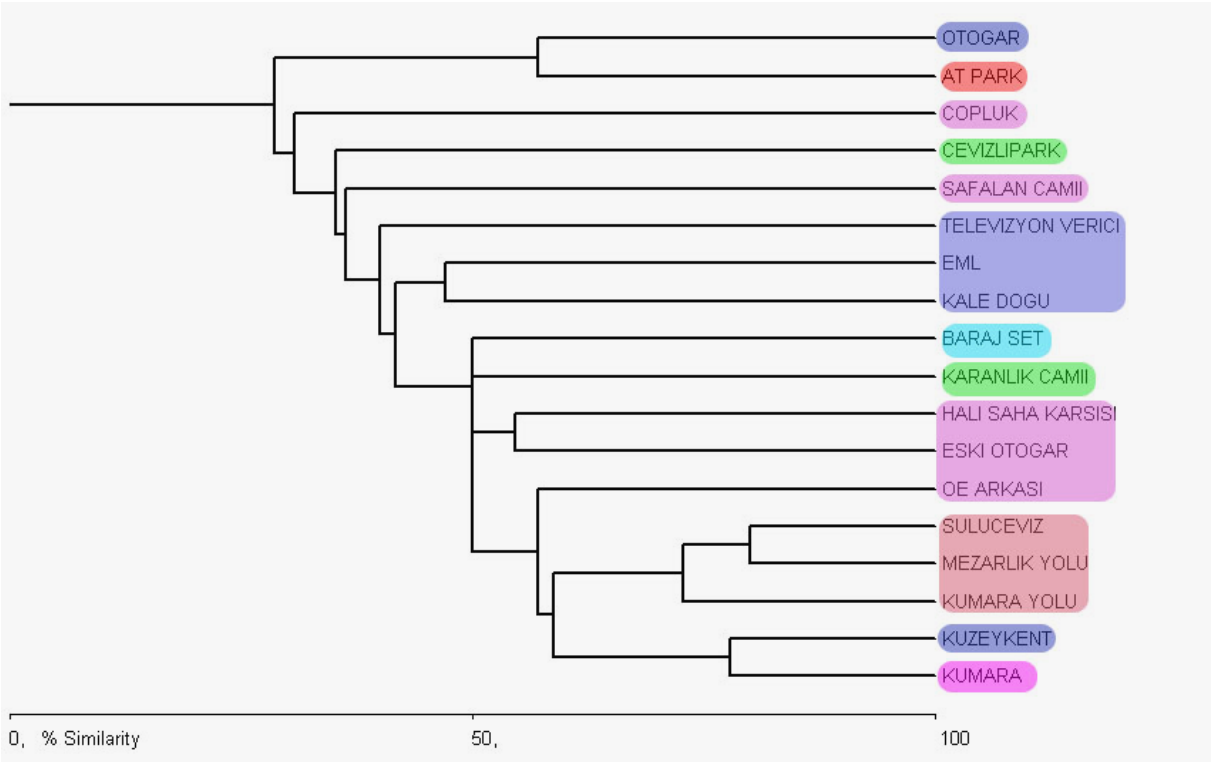



**Figure 3**. Snail species recorded only from west (left) and eastern (right) banks of Karaçomak stream

The position of section II is particularly interesting. Although sections III and VI are clustered together, this section is separated into several clusters. This implies that faunal exchanges may took place through this section. Indeed its location corresponds to narrowest part of the valley. Clustering of I and IV is due to influence of alien species, in both landscaping shapes the biotas. One other issue of particular interest is the similarity of Kuzeykent (I) and Kumara (VII), extreme north and southern edges of the city. However, the shared open land species (*P.s. incerta, C. zebrula, H. striata, H. escherichi*) could only be found within the 'valley' rarely if present. Likewise, *X. derbentina* which is sometimes invasive in Turkey (pers. observation) and occasionally elsewhere (VAN REGTEREN ALTENA, 1960) was absent from the valley bottom replacing there with translocated *X. krynickii*. This phenomenon may be related to habitat requirements or succession processes.

**Figure 4.** Cluster analysis of localities according to Bray-Curtis index (blue to green: western bank, pink to red: eastern bank of the Karaçomak stream)



There are serious differences from the point of attitude towards nature between traditional and new systems. In traditional way, houses are arranged in terrace system (in accordance with the topology) and they have small gardens. Modern buildings are close-set and high, thus they don't have lawn or garden. Furthermore, all the surface cover and vegetation is sorted out for projected landscaping. During study, it has been observed that in presence of trees like elder (*Sambucus nigra*) and substitute for calcium resource (old walls), native snails can adapt to changes. However this is very rare as a need for extra space has the privilege. *M. samsunensis* is the most successful native species to survive in small patches. In a locality in city center, a population split from the nearest one by 1 km was found in a habitat piece less than 2 $m^2$ .

5 localities (4 in section II, 1 in section V) have been destroyed during the course of study. Accordingly, the only population of endemic *S. diodon* and *M. densecostulata* on the eastern side has gone. Several other habitats were partially lost, but 1-2 year follow-up of sites convincing data about their survival. *Succinella oblonga* was found from a single site, a park above the stream. Its presence was an evidence of that the stream affected as a corridor to hygrophile snails. The reclaiming project of stream finished in August 2008 should have cleared out this species.

Presence of alien and translocated taxa is mainly linked with greening of the gardens or lawns (VON PROSCHWITZ, 2000 and 2004). In newly established (<10 years) (mainly in city center and Kuzeykent) places, no native species could be detected. But older gardens (city parks and gardens of old houses) translocated species can be together with other native species.

The absence of *Cernuella virgata* (DA COSTA, 1778), *Eobania vermiculata* (MÜLLER, 1774), and *Cornu aspersum* (MÜLLER, 1774), which are commonest introduced snails in the southern Europe and western Turkey (KERNEY & CAMERON, 1979; SCHÜTT, 2001), show that these do not show invasiveness in the environs of Kastamonu city possibly due to climatic or historical reasons. These are, with the exception of *C. virgata*, distributed sporadically in northern Turkey. Considering that the region around Kastamonu was used for settlement throughout the historical time, the presence/absence of the species may be linked with historical events. *C. virgata*, although absent from the city, may colonize artificial habitats via soil transport, sodding and construction materials in the future.

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