

Effects of human disturbance and elevational gradient on millipede diversity at kala mount, Center Cameroon

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Introduction

The upland urban areas are hotspots of endemism, but they are currently threatened by human disturbance such as urbanization. Increasing urbanization is a global concern; it affects high altitude Invertebrates, especially those which are less mobile and have specific habitat requirements, such as millipedes. Millipedes (Diplopoda) are important indicators among ground-dwelling invertebrates, as they are sensitive to habitat change. The millipede fauna of Cameroon is remarkably diverse and includes many endemic genera, yet it remains poorly documented. The available reports were focused on millipedes in lowland rainforest, but rarely in upland ecosystem. We investigated the effects of the elevation gradient and level of human disturbance on millipede communities' structure at mount Kala.

Material and methods

Study sites

Millipedes were intensively surveyed from 05 January to 06 November 2017 on mount Kala (3°50'N; 11°21'E). The mount Kala is located in Center Region, Cameroon. The inventories were conducted at the following altitudes and habitats along the elevational gradients:

- **Zone 1.** At low elevations (820-920 m), the landscape is mainly rural or semi-urban and consists of patches of agricultural lands, and villages;
- **Zone 2.** At first mid-elevations (920-1020m). This zone is dominated by mixed crops fields (*Manihot esculenta*, *Zea mays*, *Aradis hypogaea*, etc.), and deciduous forests;
- **Zone 3.** The second mid- elevations (1020-1120 m) is characterized by small forest patches , moderate canopy and litter;
- **Zone 4.** At high elevation or at the mountain top (> 1120m), the landscape is characterized by grasslands, closed canopy and forest patches.



Fig. 1. Study site (rochy slope of mount kala)

Survey methods

In each elevational zone, millipedes were surveyed using three principal methods: leaf litter sifting, pitfall, and general (hand) collecting methods (Fig. 2).

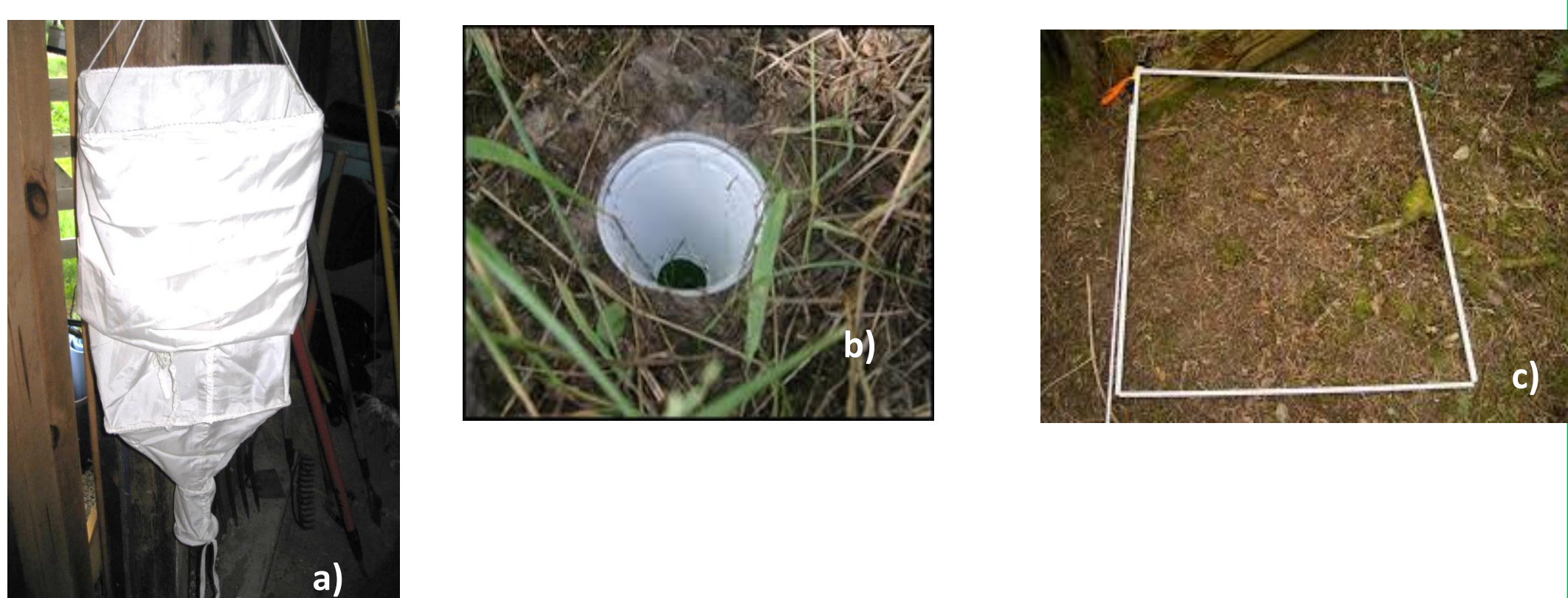
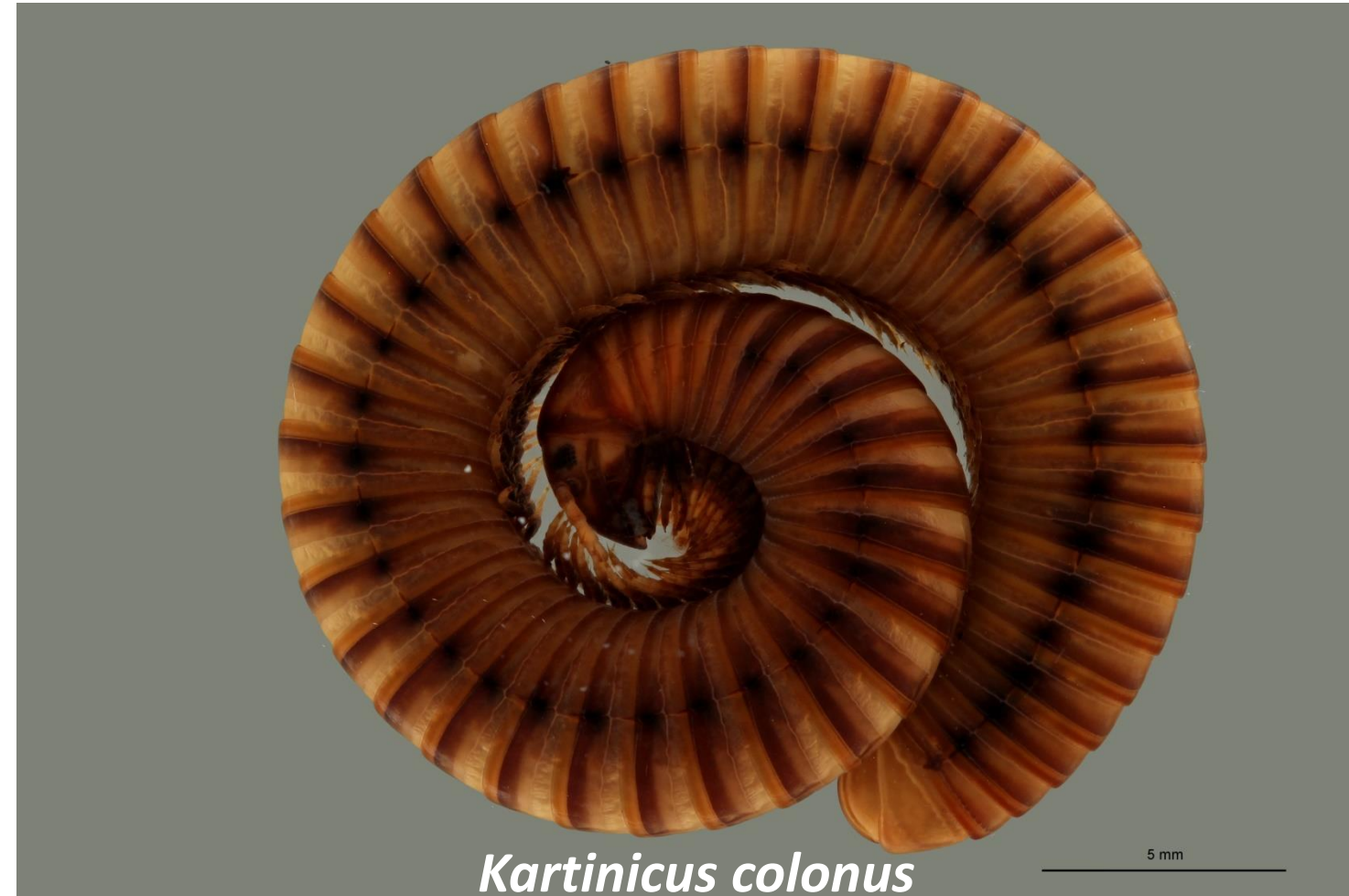


Fig. 2. Illustration of sampling methods used on mount Kala: a) litter sifting; b) pitfall, c) hand collection



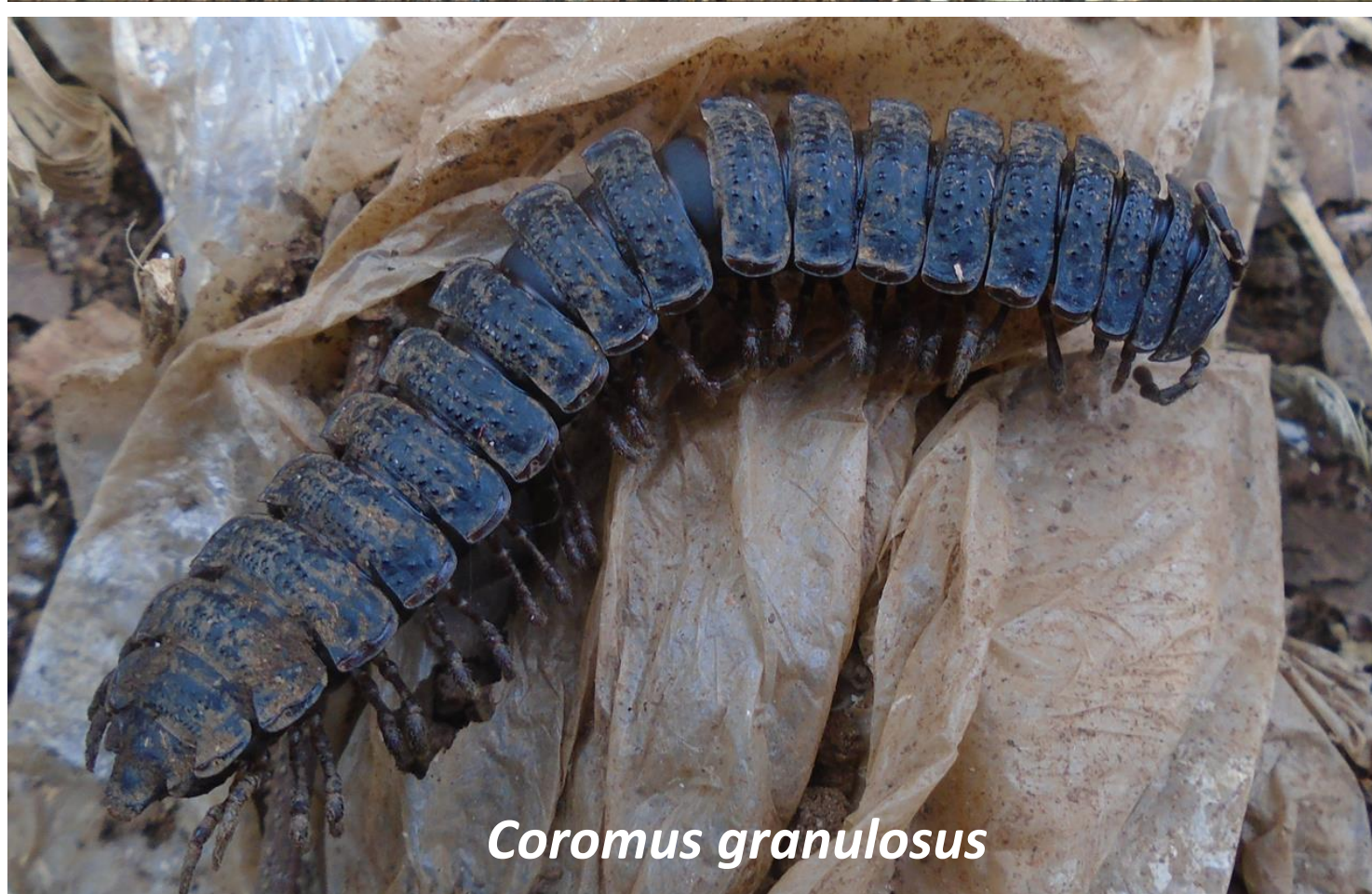
Kartinicus colonus



Pelmatojulus excisus



Odontostreptus sjoedti



Coromus granulatus



Aporodesmus gabonicus

Discussion

- ❖ Millipede diversity increases with decreasing of human disturbance along elevational gradients.
- ❖ Millipede species richness was greater in the forest patches (high altitude) than in urbanized areas (low altitude).
- ❖ Middle elevation provides more ressource opportunities than lower and higher altitudes.
- ❖ Climatic constraints occur at high altitude may also have a negative impact on millipede diversity (only specialized species can survive in such conditions).

Results

Myriapod community structure

A total of 1071 millipede individuals were recorded and identified to 52 species from 4 orders representing 11 families and 32 genera (Table 1). Polydesmida was the most abundant and species-rich order (49.11%; 28 species) followed by Spirostreptida (33.42%; 20 species), Spirobolida (15.77%; 3 species) and Stemmiulida (1.68%; species) (Fig. 3a). The species-rich family was Spirostreptidae (15 species) followed by Chelodesmidae (7 species), Odontopygidae, Gomphodesmidae and Cryptodesmidae with 5 species each (Fig.3b).

Table 1. List of orders, families, genera and species recorded on mount Kala

Order	Family	Genera	Species
Polydesmida	6	18	28
Spirobolida	2	3	3
Spirostreptida	2	10	20
Stemmiulida	1	1	1
Total	11	32	52

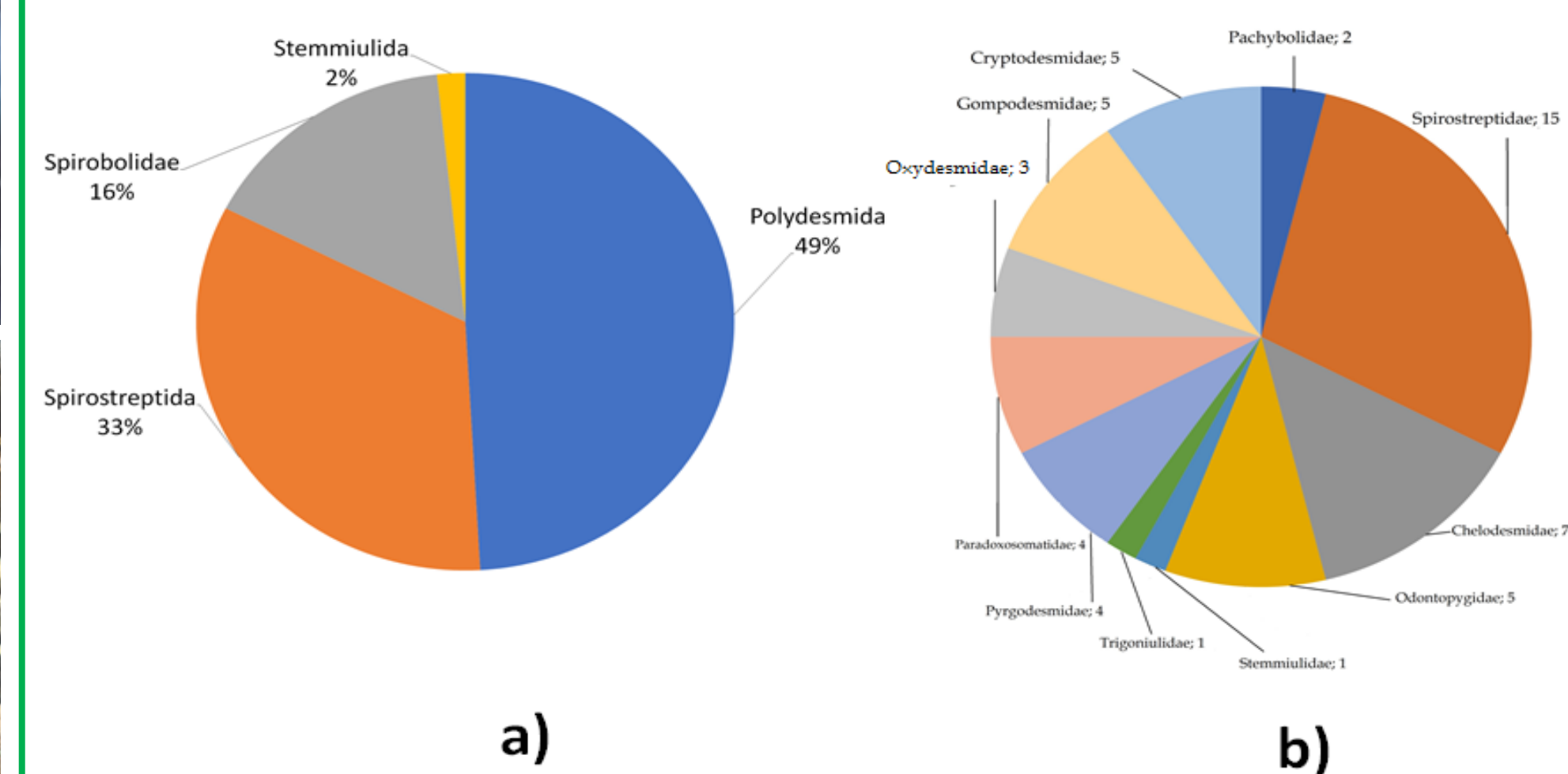


Fig 3. Abundance and species-richness patterns of orders (a) and families (b) of millipedes of mount Kala.

Distribution patterns of species richness and abundance

Along the elevational gradients, millipede richness first increased from 34 to 36 species at low altitude (820 -920 m) and reached a peak, and then decreased from 34 to 32 at high altitude (1020-1125 m).

The relative abundance pattern of five most abundant millipede species varied significantly between different altitudes (Fig. 4). *Aporodesmus gabonicus* abundance decreased from 14.1 to 13.3% (820-1020 m), increased and reached a maximum of 49.74 % (1020-1120m), and decreased to 15.5% (>1120m). For other species such as *Kartinicus colonus* and *Amblybolus laevis*, the relative abundance reached a mid-elevational peak and then decreased at high altitude.

Three species were unique in the zone 1 (*Oxydesmidae* Gen. sp., *Scolodesmus grallator*, *Tymbodesmus falcatus*) , three in the zone 2 (*Paracordylidae* sp. , *Pyrgodesmidae* Gen. sp., *Spirostreptus laevis*), three in the zone 3 (*Coromus* sp., *Scolodesmus* sp.2, *Urotropis propinqua*), and four in the zone 4 (*Odontopyge bipartita*, *Onychostreptus assiniensis*, *Spirostreptus amandus*, *Tymbodesmus* sp.2).

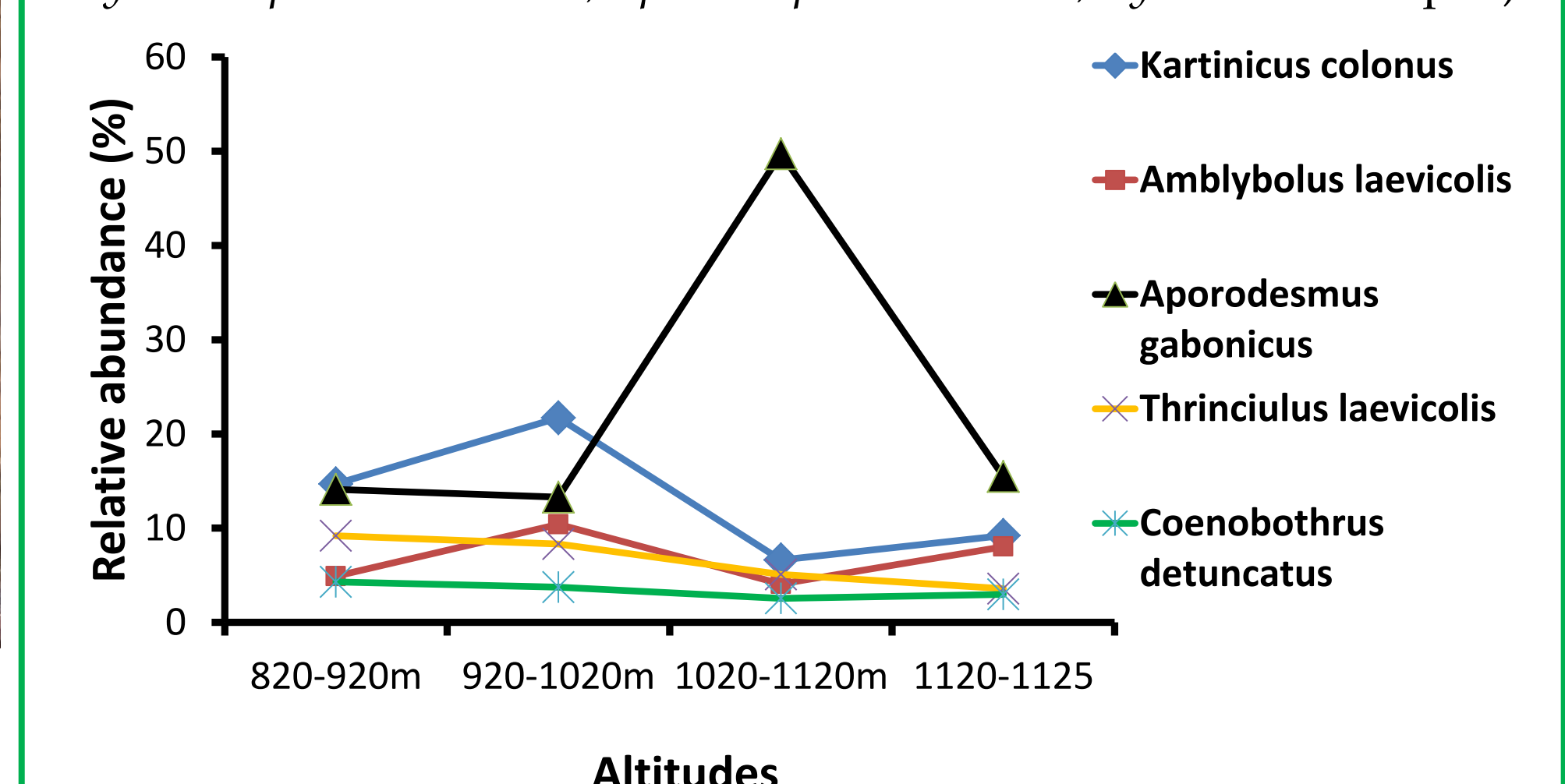


Fig.4. Relative abundance of five most abundant species at different altitudes of mount kala

Conclusion

The mount kala is very rich in regard to millipde diversity with 52 species belonging to 11 families and 32 genera. This suggest that mount kala should be prioritised as areas for further intense conservation.

Human disturbance and abiotic factors such as temperature strongly affects pattern of abundance, distribution and diversity of millipedes along elevational gradients.