

Full Length Research Paper

Invertebrate fauna associated with the cultivation of *Vernonia calvoana calvoana* (Asteraceae) in Yaoundé (Center-Cameroon)

EBANGUE TITTI Oscar Giovanni William^{1*}, MONY Ruth¹ and NOLA Moïse²

¹Laboratory of Zoology, Faculty of Science, University of Yaoundé 1, Cameroon.

²Laboratory of Hydrobiology and Environment, Faculty of Science, University of Yaoundé 1, Cameroon.

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***Vernonia calvoana* is a culture spread across the world and prized for its culinary and medicinal virtues. The data was collected in Yaoundé, Central Cameroon region through manual harvesting at two stations from 2017 to 2019. A total of 168 species or morphospecies belonging to 47 families and 12 orders from two phyla were collected. The most abundant phylum was Arthropoda which represented 99.96% of the total number of all species, while Mollusca represented the rest. Within arthropoda, insecta class was found the most dominant. In Insecta, Formicidae and Aphididae were the most frequent families. At Nkolbisson, Hymenoptera and Hemiptera are more abundant on the purple variety than on the white variety. However, both are less abundant compared to those at Nlong-mvolye. The species *Uroleucon compositae* (37.01%), *Hilda cameroonensis* (4.67%) and *Sphaerocoris annulus* (2.71%) were the most abundant species recorded in all the three variants. Depending on the preference with the host plant, some orders have a distribution according to the site, but also, the variety.**

Key words: Manual harvest, insecta, hymenoptera, hemiptera, Nkolbisson, Nlong-mvolye.

INTRODUCTION

Recent demographic studies predict that by 2050, the human population could reach a total of 9.7 billion people (Godfray et al., 2010). In addition, research suggests that such an increase in population would also be accompanied by various modifications of our planet such as the reduction of arable land characteristic of urban development, or, the increase of problems related to climate change such as food insecurity and health crises (Godfray et al., 2010; Pison, 2011).

Despite efforts to find alternative and sustainable

solutions such as the implementation of increased global production and better management related to agricultural losses, the development of these strategies is slowed down by various challenges on a global or local scale. For example, many species of invertebrates are pests and vectors of diseases that hinder the development of sustainable agriculture (Liu and Sparks, 2001; Geering and Randles, 2012). This is especially in the countries of subtropical Africa. Invertebrates constitute about 80% of animal biomass. The most cited in the literature that

*Corresponding author. E-mail: tigiodido@gmail.com.

causes the most crop damage are: Hemiptera, Orthoptera, Coleoptera and Lepidoptera.

The Asteraceae is one of the four most diverse families with over 1,500 genera and 23,000 species (Ehab, 2001). They are distributed throughout the world. Within the Asteraceae, the genus *Vernonia* is the most diverse with 1000 listed species (Keeley and Jones, 1979). Species of the genera *Vernonia* are prized either for their culinary or medicinal virtues. Its consumption is based on the belief that the plant is used in the management and cure of heart diseases, blindness, diabetes, malaria, stomach ache, as an anti-helminthic agent, and to prevent constipation. Preliminary pharmacological studies carried out on experimental models have validated the hypoglycemic and hypolipidemic (Iwara et al., 2015), antioxidant (Egbung et al., 2016; Iwara et al., 2017), antimicrobial (Ati et al., 2016), cardio-protective (Egbung et al., 2017), and anti-cancer properties of *V. calvoana* (Mbemi et al., 2020). In Cameroon, *Vernonia amygdalina*, *Vernonia colorata* and *Vernonia calvoana* are united under the name 'ndolè'. According to Kahane et al. (2005), 'ndolè' is the sixth Cameroonian dish. In Cameroon *V. amygdalina* and *V. calvoana* are the most common species. Moreover, *V. amygdalina* can be substituted by *V. calvoana* (Grubben and Denton, 2004). Many studies have already focused on *V. amygdalina* while *V. calvoana* has been the subject of few studies. In order to contribute to integrated pest management, knowledge of the different groups of invertebrates associated with the culture of *V. calvoana* is necessary. This present work aims to determine the diversity of the invertebrate fauna associated with the culture of *V. calvoana* in the city of Yaoundé.

MATERIALS AND METHODS

Study site

The study was conducted from August 2017 to April 2019 in two districts of the city of Yaoundé (Department of Mfoundi) (Figure 1). The city of Yaoundé is influenced by a Guinean-type equatorial climate with four seasons: a large dry season (from mid-November to mid-March); a small rainy season (from mid-March to the end of June); a small dry season (July to August); and a large rainy season (September to mid-November). Precipitation is in the range of 1400 to 1900 mm per year and temperatures vary from 18 to 35°C (Suchel, 1988).

Plant material

The plant material consists of the white and purple varieties of *V. calvoana calvoana* quite common in the Central region.

Experimental design

At the main station located in the Nkolbisson district, on an area of 530 m², three complete randomized blocks made up of eight experimental units of square shape and 16 m² of surface each, spaced 0.8 m. Each experimental unit had five rows of 5 plants

spaced 0.80 m each. At the peripheral station in Nlong-mvolye, on a surface of 412 m², we placed plants of *V. calvoana calvoana* white variety in association with *Abelmoschus esculentus*, *V. amygdalina*, *Solanum modiflorum*, *Amaranthus hybridus*, *Phaseolus vulgaris*, and *Talinum fruticosum*.

The main station included the white (12 plots) and purple (12 plots) varieties of *V. calvoana calvoana* while the peripheral station only contains the white variety. The invertebrates were collected from August 2017 to September 2018 in Nkolbisson and from March 2018 to April 2019 in Nlong-mvolye.

Sampling method

Hand collection was the sampling technique used to collect invertebrate species to occur in each location. Two persons used either forceps or aspirator to collect species on aerial organs (leaf and stems) of plant for 5 min. Collections from *V. calvoana calvoana* plants were weekly, five plants randomly selected by plots. A total of 120 plants were sampled in Nkolbisson and 60 plants in Nlong-mvolye.

The collected invertebrates were stored in tubes containing 70% alcohol and identified using the appropriate dichotomous keys. The correct specimens were deposited in the reference collection in the Zoology Laboratory of the University of Yaoundé 1.

Data analysis

After identification, cumulative and relative abundances of invertebrates hosted by each plant species/varieties were computed. For further analysis, taxa (orders, the families and the species) with $\geq 5\%$; $5\% < \text{relative abundance} \geq 1\%$ were considered dominant and less abundant, respectively. While those with abundance $< 1\%$, were considered scarce during the study. We used the Excel software for the frequency calculation and the Past 3.12 software to generate the diversity indexes.

RESULTS

Diversity associated with *V. calvoana calvoana*

A total of 168 species of invertebrates belonging to two phyla, 12 orders and 47 families identified from 13,929 individuals were collected. The phylum of Arthropoda is more diverse (11 orders, 47 families and 167 species) and abundant (13,925 individuals or 99.96% of individuals collected) than the phylum of Mollusca (one order, one family and one species). The arthropods were grouped into 03 classes: the Arachnida (with an order, 6 families and 18 species), the Diplopoda (with an order, a family and a species), and the Insecta (with 9 orders 40 families and 149 species).

Diversity at the ordinal level

Among these invertebrates, four orders of insects are the most abundant in terms of specific richness (that is 99.25% of the total number of individuals collected). These orders include the Hymenoptera (3 families and 18 species), 6850 individuals or 49.32% of the individuals

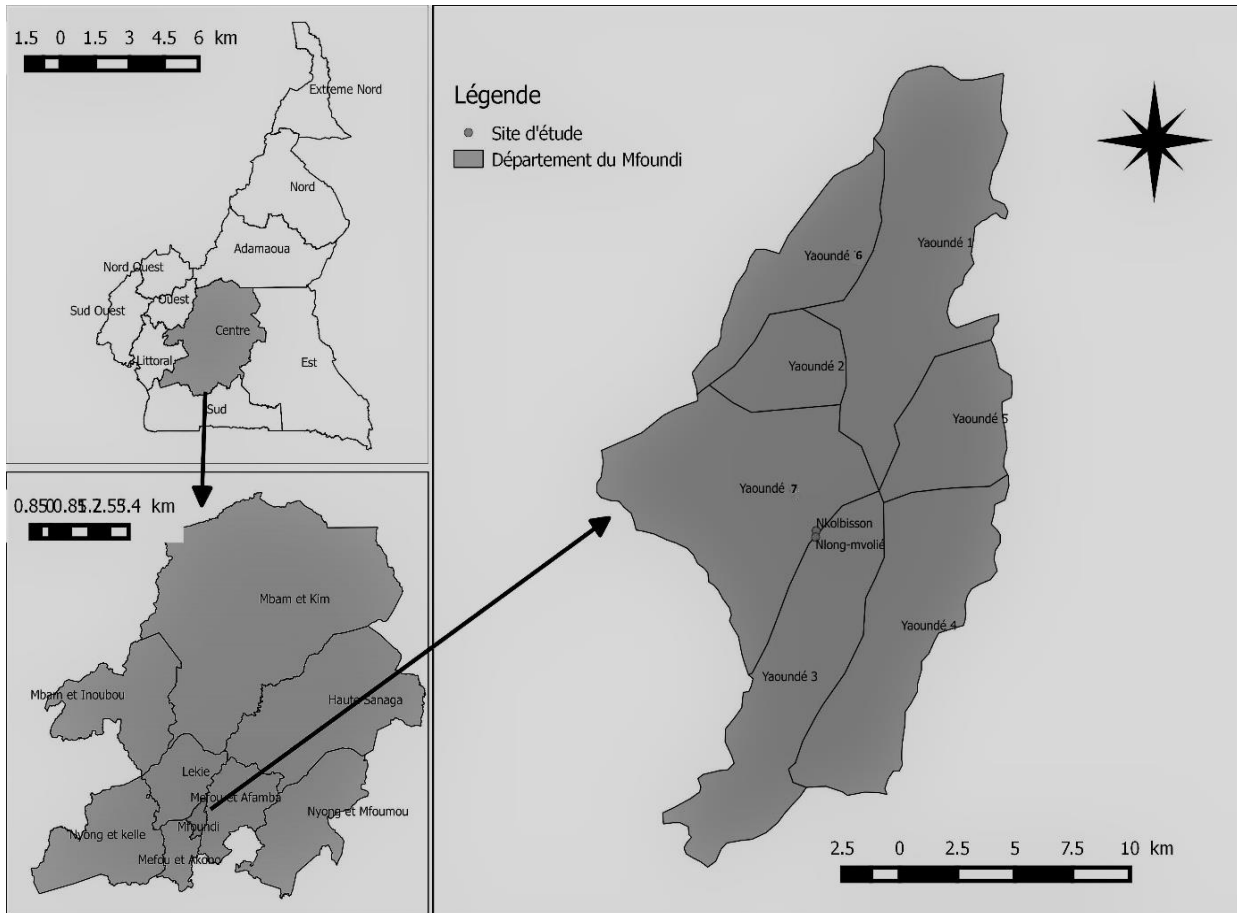


Figure 1. Locations of the surveyed sites in Nkolbisson and Nlong-mvolye in Central Region, Cameroon.

collected; Hemiptera (13 families and 41 species) 6,388 individuals, that is, 45.72% of the individuals collected; Coleoptera (7 families and 44 species) 401 individuals or 2.88% of individuals collected; and Orthoptera (8 families and 13 species) 185 individuals or 1.33% of individuals collected (Table 1).

Diversity at the family level of the most abundant orders

Without taking into account the location and the variety, 47 families were identified on *V. calvoana calvoana*, only two families belonging to Insecta have a frequency $\geq 5\%$ (Table 2). This community is dominated by the Formicidae (49.31%) and Aphididae (37.01%) families. Also, four families, namely, Tettigometridae (4.67%), Pentatomidae (2.79%), Coccinellidae (2.07%), and Pyrgomorphidae (1.03%) were numerically significant with an abundance ≥ 1 (Table 2). The purple variety was the most diverse (Table 3). The activities of the species of these families contribute to weakening the growth and the yield of the plant.

Diversity at a specific level

The Hemiptera are the most diverse with 13 families and 41 species. The most abundant species are *Uroleucon compositae* (Theobalt, 1915), *Hilda cameroonensis* (Tamesse and Dogmo, 2016) and *Sphaerocoris annulus* (Fabricius, 1775) (Table 4).

U. compositae and *H. cameroonensis* have a regular distribution regardless of site and variety, while *S. annulus* seems to have a preference for the white variety in Nkolbisson (Table 4).

The order Hymenoptera is represented by three families and 18 species. The most abundant species are *Pheidole megacephala* (Fabricius, 1793), *Diplomorium longipenne* (Mayr, 1901), *Camponotus acvapimensis* (Mayr, 1862), *Myrmicaria opaciventris* (Emery, 1893), and *Tetramorium acculeatum* (Mayr, 1866) (Table 4).

The order Coleoptera is represented by seven families and 44 species, with the most abundant species being Coccinellidae species. The latter is being better represented in Nkolbisson regardless of the variety (Table 4).

The order Orthoptera is represented by eight families

Table 1. Assemblages of orders of invertebrates collected according to different varieties.

Order	The abundance of invertebrate per varieties			
	B1	B	V	Total general
Aranea	3 (0.05)	12 (0.35)	9 (0.21)	24 (0.17)
Blattodae	0 (0)	0 (0)	1 (0.02)	1 (0.01)
Coleoptera	17 (0.28)	211 (6.08)	173 (4.01)	401 (2.88)
Dermaptera	2 (0.03)	0 (0)	5 (0.12)	7 (0.05)
Diptera	1 (0.02)	11 (0.32)	9 (0.21)	21 (0.15)
Hemiptera	3180 (51.73)	1269 (36.57)	1919 (44.5)	6368 (45.72)
Hymenoptera	2930 (47.67)	1865 (53.75)	2075 (48.12)	6870 (49.32)
Lepidoptera	6 (0.1)	12 (0.35)	20 (0.46)	38 (0.27)
Mantoptera	1 (0.02)	3 (0.09)	5 (0.12)	9 (0.06)
Orthoptera	5 (0.08)	86 (2.48)	94 (2.18)	185 (1.33)
Spirostreptida	0 (0)	0 (0)	1 (0.02)	1 (0.01)
Stylomatophora	2 (0.03)	1 (0.03)	1 (0.02)	4 (0.03)
Total general	6147 (100)	3470 (100)	4312 (100)	13929 (100)

Values in brackets represent relative abundance. B1: White variety of *V. calvoana calvoana* in Nlong-mvolye; B: White variety of *V. calvoana calvoana* from Nkolbisson; V: Purple variety of *V. calvoana calvoana* from Nkolbisson.

and 13 species, with the most abundant species being *Zonocerus variegatus* (Linnaeus, 1758) (Table 4). *Z. variegatus* is only distributed in Nkolbisson regardless of the variety (Table 4).

DISCUSSION

The present study showed that 168 species of invertebrates belonging to two phyla, 12 orders and 47 families were associated to *V. calvoana calvoana*. Our results are more diverse than the 31 families and 92 species obtained on *Carthamus tinctorius* (Asteraceae) by Saeidi et al. (2015) in Iran as well as the 30 and 36 families obtained, respectively on both *Tithonia rotundifolia* and *Tithonia diversifolia* Asteraceae by Donatti-Ricalde et al. (2018) in Brazil. This difference could be due to on one hand a much longer sampling period than theirs and to the other hand, the geographical variation of the sites. In addition, our results are less diverse than the 20 orders, 117 families and 412 species collected by Kakam et al. (2020) on 11 varieties of seven species of Curcubitaceae, in Minko'o in the South Cameroon region. This difference could be due to on one hand the number of varieties and species greater than that of our study. On the other hand, it could also be due to the fact that Curcubitaceae seems to attract more species than Asteraceae. The work also reveals the presence of Insecta, other classes like Diplopoda (Odontopygidae) and Gasteropoda.

The present results corroborate with those of Selim (1978) in Iraq and Campobasso et al. (1999) in India on *C. tinctorius* with regard to the dominance of Insecta over other invertebrate classes. This result would be because Insecta are the most abundant and diverse clade of the Invertebrate clade (Basset et al., 2012). In addition,

the present results are different from theirs when it comes to composition. Indeed, their results revealed the dominance of Coleoptera, Diptera, Hemiptera, Lepidoptera and Thysanoptera as the most abundant orders. This difference could be due to climatic variations and the number of sampling methods but also the area of the fields. Indeed, Saeidi et al. (2015) used three sampling methods: sweep netting, yellow sticky trap, and pitfall trap. Also, the size of the farms was about 1000 m² in the present work against 6000 m². The present study does not reveal the presence of Thysanoptera.

This difference would be due to the mode of organization of Formicidae and Aphididae which live in colony on one hand and their great reproductive capacity on the other hand.

U. compositae has been reported as a pest of *C. tinctorius*. Ishaq et al. (2004) specified which is at the origin of crop losses ranging from 35 to 72%. In Cameroon, this is the first time that it has been reported on *V. calvoana calvoana*. *H. cameroonensis* was listed by Tamesse and Dogmo (2016) as a pest of *V. amygdalina* (Asteraceae). It is being reported for the first time on *V. calvoana calvoana*. *Z. variegatus*, polyphagous, which can develop on *V. amygdalina* is also reported on *V. calvoana calvoana*.

Conclusion

The present study shows that the invertebrate fauna of *V. calvoana calvoana* is diverse. It is grouped into 12 orders, 47 families and 168 species. The phytophagous species are concentrated in the order Hemiptera. The most abundant species are *U. compositae*, *H. cameroonensis* and *S. annulus*. There is little variation in diversity between varieties and sites.

Table 2. List of different families of invertebrates (relative abundance above 1%) collected during the study.

Family	The abundance of invertebrate per varieties			
	B1	B	V	Total general
Achilidae	0 (0)	1 (0.03)	0 (0)	1 (0.01)
Acrididae	0 (0)	3 (0.09)	4 (0.09)	7 (0.05)
Aphididae	2859 (46.51)	872 (25.13)	1424 (33.02)	5155 (37.01)
Apidae	0 (0)	1 (0.03)	2 (0.05)	3 (0.02)
Apionidae	0 (0)	0 (0)	1 (0.02)	1 (0.01)
Araneidae	0 (0)	0 (0)	1 (0.02)	1 (0.01)
Asteiidae	0 (0)	2 (0.06)	4 (0.09)	6 (0.04)
Bibionidae	1 (0.02)	1 (0.03)	0 (0)	2 (0.01)
Blattidae	0 (0)	0 (0)	1 (0.02)	1 (0.01)
Braconidae	1 (0.02)	0 (0)	0 (0)	1 (0.01)
Cantharidae	1 (0.02)	0 (0)	0 (0)	1 (0.01)
Cercopidae	0 (0)	4 (0.12)	4 (0.09)	8 (0.06)
Chrysomelidae	6 (0.1)	56 (1.61)	39 (0.9)	101 (0.73)
Cicadellidae	1 (0.02)	5 (0.14)	4 (0.09)	10 (0.07)
Coccinellidae	8 (0.13)	153 (4.41)	127 (2.95)	288 (2.07)
Coreidae	8 (0.13)	10 (0.29)	3 (0.07)	21 (0.15)
Culicidae	0 (0)	1 (0.03)	4 (0.09)	5 (0.04)
Curculionidae	2 (0.03)	1 (0.03)	3 (0.07)	6 (0.04)
Formicidae	2929 (47.65)	1867 (53.8)	2072 (48.05)	6868 (49.31)
Gryllidae	0 (0)	1 (0.03)	5 (0.12)	6 (0.04)
Jassidae	1 (0.02)	2 (0.06)	1 (0.02)	4 (0.03)
Lauxaniidae	0 (0)	1 (0.03)	0 (0)	1 (0.01)
Lycidae	0 (0)	1 (0.03)	2 (0.05)	3 (0.02)
Lycosidae	0 (0)	1 (0.03)	2 (0.05)	3 (0.02)
Mantodae	1 (0.02)	3 (0.09)	5 (0.12)	9 (0.06)
Membracidae	5 (0.08)	2 (0.06)	5 (0.12)	12 (0.09)
Muscidae	0 (0)	2 (0.06)	0 (0)	2 (0.01)
Myodochidae	2 (0.03)	30 (0.86)	26 (0.6)	58 (0.42)
Odontopygidae	0 (0)	0 (0)	1 (0.02)	1 (0.01)
Others families	11 (0.18)	21 (0.61)	29 (0.67)	61 (0.44)
Passalidae	0 (0)	0 (0)	1 (0.02)	1 (0.01)
Pentatomidae	1 (0.02)	192 (5.53)	195 (4.52)	388 (2.79)
Pipunculidae	0 (0)	1 (0.03)	0 (0)	1 (0.01)
Plataspidae	0 (0)	2 (0.06)	6 (0.14)	8 (0.06)
Pyrgomorphidae	0 (0)	68 (1.96)	75 (1.74)	143 (1.03)
Pyrrhocoridae	10 (0.16)	19 (0.55)	13 (0.3)	42 (0.3)
Reduviidae	0 (0)	3 (0.09)	2 (0.05)	5 (0.04)
Rhaphidophoridae	2 (0.03)	4 (0.12)	2 (0.05)	8 (0.06)
Salticidae	1 (0.02)	2 (0.06)	1 (0.02)	4 (0.03)
Solenopidae	0 (0)	0 (0)	2 (0.05)	2 (0.01)
Syrphidae	0 (0)	3 (0.09)	1 (0.02)	4 (0.03)
Tetrigidae	1 (0.02)	0 (0)	1 (0.02)	2 (0.01)
Tettigometridae	293 (4.77)	122 (3.52)	236 (5.47)	651 (4.67)
Tettigoniidae	2 (0.03)	8 (0.23)	6 (0.14)	16 (0.11)
Theridiidae	1 (0.02)	1 (0.03)	0 (0)	2 (0.01)
Thomisidae	0 (0)	2 (0.06)	1 (0.02)	3 (0.02)
Trigonidiidae	0 (0)	2 (0.06)	1 (0.02)	3 (0.02)
Total general	6147 (100)	3470 (100)	4312 (100)	13929 (100)

Values in brackets represent relative abundance. B1: White variety of *V. calvoana calvoana* in Nlong-mvolye; B: White variety of *V. calvoana calvoana* from Nkolbisson; V: Purple variety of *V. calvoana calvoana* from Nkolbisson.

Table 3. Variant diversity indices at the family level.

Index	B	B1	V
Richness	39	23	35
Abundance	4450	6147	3332
Simpson_1-D	0.64	0.55	0.66
Shannon H	1.45	0.93	1.48
Equitability_J	0.40	0.30	0.42
Berger-Parker	0.54	0.48	0.47

B1: White variety of *V. calvoana calvoana* in Nlong-mvolye; B: White variety of *V. calvoana calvoana* from Nkolbisson; V: Purple variety of *V. calvoana calvoana* from Nkolbisson.

Table 4. List of the most abundant species of invertebrates (relative abundance above 1 %) collected during the study period.

Species	The abundance of invertebrate per varieties			
	B1	B	V	Total general
<i>Camponotus acvapimensis</i>	1 (0.02)	525 (15.13)	356 (8.26)	882 (6.33)
<i>Coccinellidae</i> sp.	7 (0.11)	131 (3.78)	103 (2.39)	241 (1.73)
<i>Diplomorium longipenne</i>	0 (0)	697 (20.09)	1056 (24.49)	1753 (12.59)
<i>Hilda cameroonensis</i>	293 (4.77)	121 (3.49)	236 (5.47)	650 (4.67)
<i>Myrmicaria opaciventris</i>	0 (0)	147 (4.24)	390 (9.04)	537 (3.86)
<i>Pheidole megacephala</i>	2858 (46.49)	148 (4.27)	199 (4.62)	3205 (23.01)
<i>Sphaerocoris annulus</i>	1 (0.02)	189 (5.45)	188 (4.36)	378 (2.71)
<i>Tetramorium acculeatum</i>	12 (0.2)	298 (8.59)	22 (0.51)	332 (2.38)
<i>Uroleucon compositae</i>	2859 (46.51)	872 (25.13)	1424 (33.02)	5155 (37.01)
<i>Zonocerus variegatus</i>	0 (0)	67 (1.93)	73 (1.69)	140 (1.01)
Total general	6031 (98.11)	3195 (92.07)	4047 (93.85)	13273 (95.29)

Values in brackets represent relative abundance. B1: White variety of *V. calvoana calvoana* in Nlong-mvolye; B: White variety of *V. calvoana calvoana* from Nkolbisson; V: Purple variety of *V. calvoana calvoana* from Nkolbisson.

Recommendations

For future work, the nature of the damage related to the invertebrate fauna present on *V. calvoana calvoana* will be investigated.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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