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DOMINANCE VALUE AND COMMUNITY PRODUCTION OF DESERT ARTHROPODA IN QATAR

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معدل الأهمية وإنتاجية المجتمع لمفصليات الأرجل الصحراوية في قطر

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ملخص البحث

تم جمع عينات من مفصليات الأرجل من بيئات مختلفة في الصحراء القطرية وذلك في نهاية فصل الصيف (أكتوبر) وبداية فصل الربيع (أبريل) للأعوام ١٩٩٥م و ١٩٩٦م و ١٩٩٧ . حدد معدل الأهمية بين الأنواع وكذلك إنتاجية المجتمع في المستويات الغذائية المختلفة . قياساً على المعدل المئوي (صفر إلى ٣٠٠٪) المعتمد لتحديد معدل الأهمية فإن جميع أنواع مفصليات الأرجل التي تم جمعها تقع حصيلة أهميتها تحت ١٠٠٪ . ولذلك تعتبر قليلة الكثافة ونادرة . خنفس التنيبريونيد من نوع أديسميا كانسلاتا والسمك الفضي من جنس ثيرموبيا سجلا أعلى معدل للأهمية . سجلت علاقة خطية إيجابية ضعيفة بين الكتلة الحية للنباتات وكثافة مفصليات الأرجل بينما لا توجد علاقة خطية بين كتلة النباتات الحية وتنوع مفصليات الأرجل أو كتلتها الحية . تبين أن مفصليات الأرجل الرمية تتفوق في الكثافة والتنوع على المستويات الغذائية الأخرى بينما تتفوق المعشبات في الكتلة الحية . تستفيد المعشبات بحوالي ٤٥ , ٠٪ فقط من الإنتاج النباتي بينما تنقل اللاحمات ٥ , ٢٠٪ من إنتاج المعشبات وتمثل الطاقة المنقولة بواسطة مفصليات الأرجل الرمية ٤٤٪ من مجموع طاقة المعشبات واللاحمات و ٢٤ , ٠٪ من الإنتاج النباتي .

Key Words : Qatar, Desert, Arthropoda

ABSTRACT

Diurnal sampling of epigeal Arthropoda from different desert habitats in Qatar was carried out at the end of the summer season (October) and in spring (April) of 1995, 1996 and 1997. Dominance values of the species collected and community production at various trophic levels have been determined. Judging by the 0-300% scale of dominance value, all arthropod species collected lie between 0-100% which indicates their small numbers and rarity. The tenebrionid beetle *Adesmia* *cancellata* L. and the thysanuran *Thermobia* sp. scored the highest domincance value. A week positive correlation between plant biomass and arthropod density was shown. No correlation was found to exist between plant biomass and arthropod diversity or biomass. Detrivores are dominant in both density and diversity but come second to herbivores in biomass. Carnivores exhibit a low but a stable level. The ratio of arthropod biomass to plant biomass, demonstrates that herbivores make use of 0.45% of the available primary production. Carnivores make up the equivalent of 20.5% of herbivore biomass. Detrivore biomass represents as much as 44% of the total of herbivore and carnivore biomass but the equivalent of only 0.24% of plant biomass.

INTRODUCTION

The Qatari Desert, lying between 50° 45′ - 51° 40′ E longitude and 24° 27′ - 26° 10′ N latitude, is an extension of the Arabian Desert. The former is characterized by very hot summers and mild winters. The mean annual temperature is 42° C while the mean minimum can reach 12° C. Rainfall is low averaging 77,4 mm/annum (1).

Information about the ecology of the desert Arthropoda in Qatar is scanty. Few taxonomic lists have been published (2, 3, 4). A recent field study has been conducted on the density and diversity of desert arthropods in Qatar (5). This revealed that the class Insecta was dominant in both density and diversity. Arthropod diversity was highest in sand dune habitats, while higher densities were recorded in depressions, locally named *rodat.*

Salt mud-flats or *sabkhat* sustained the lowest density. In general, the density and diversity of desert arthropods in Qatar was lower than in the Namib Desert (6), or the Mojave Desert (7, 8, 9). Nevertheless the Qatari Desert, though dry for most of the year and of limited area, embodies distinct localized habitats supporting diverse assemblages of arthropods. They constitute the bulk of animal biomass (5).

The present analysis is a further clarification of the role played by arthropods in the structure and function of the desert ecosystem in Qatar. Dominance values, community production and energy transfer have been investigated. Such biological relationships within the desert biome are up to now not quantitatively understood, as most of the work done has been descriptive (10). However, few numerical evaluations of biomass production and energy expenditure of desert arthropods have been reported (11, 12). The average species richness at different trophic levels of desert arthropods was assessed by Crawford and Seely (6). These authors reported that the species richness of detrivores and carnivores was similar among Namib Desert dunefield arthropda, but individual numbers and total biomass were much greater for detrivores. Tenebrionid Beetles averaged about one third of all trapped species, and their richness and individual abundance were reported by the authors to be highly habitat specific.

Methods

Diurnal (09.00-1200) samples of epigeal arthropods were collected from different desert habitats in Qatar (Fig. 1). These habitats included land-depressions locally named *roda*, sanddunes and saline mud-flats (*sabkha*). Sampling was carried out in October, the end of the summer season, and in April which is considered to be spring time. The work continued during the years 1995, 1996 and 1997. Wooden quadrates, (m^2) were used for random sampling of the plants while arthropods were collected alive by hand or with sweep nets within 100 m^2 quadrates marked by coloured pegs.

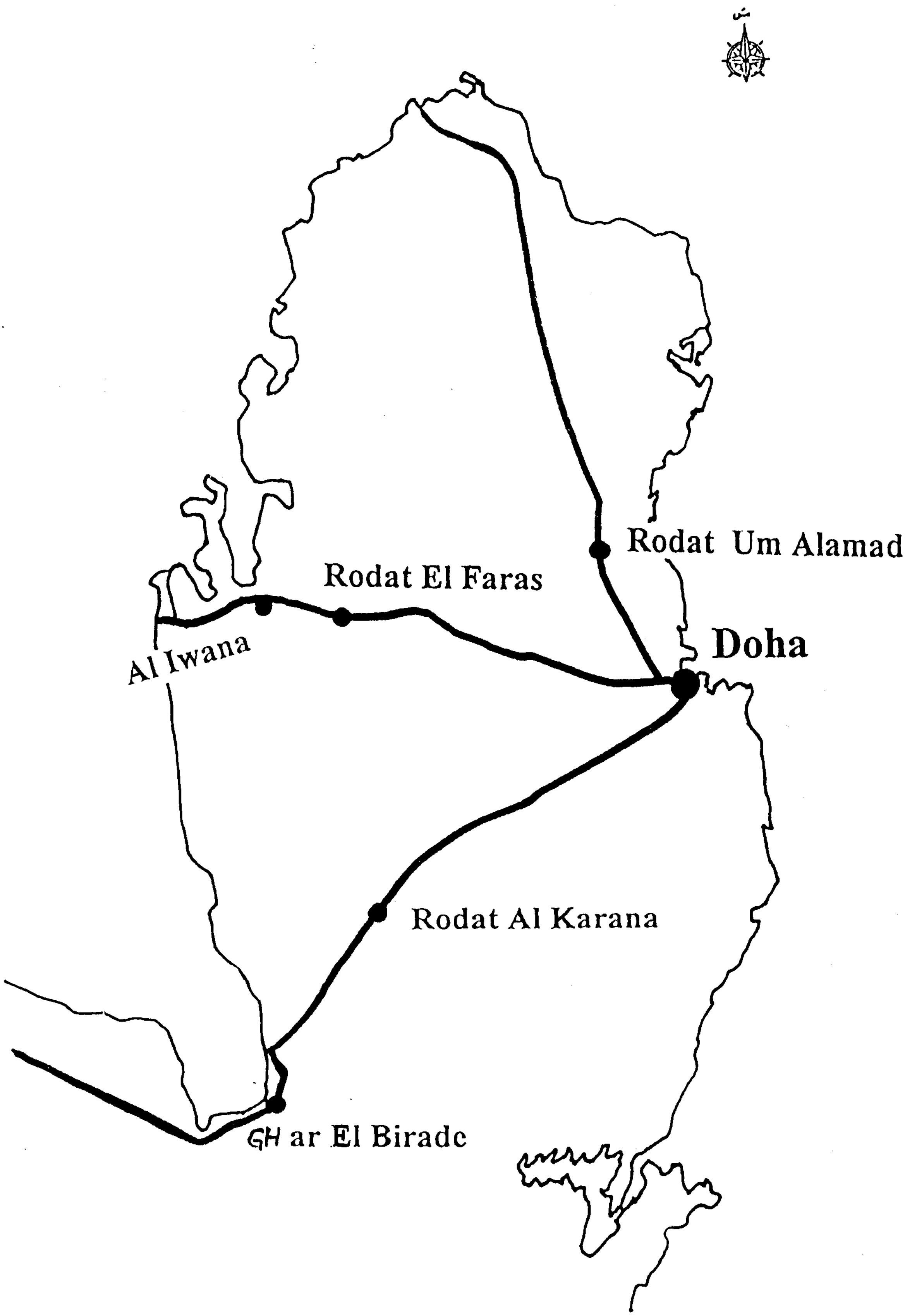

Fig. 1: Map of Qatar showing study localities.

Macroclimatic factors, such as air temperature and relative humidity, soil surface temperature and wind-speed were recorded simultaneously using appropriate instruments. Soil moisture , the organic content and salt content of soil samples from the different localities were determined by drying, burning and conductivity methods respectively (Table 1).

Identification of arthropods to species level was based on identification keys (13 and 14) and published lists of local collections (15, 22, 23 and 24). Biomass of producers and consumers at different trophic levels was considered a measure of community production. Statistical analysis was carried out with the help of SPSS for windows.

Results

A list of the arthropoda species collected, the cumulat ive number of individuals within the quadrates and frequency of occurrence are shown in Table 2. Forty-eight species belonging to four classes and fifteen orders of Arthropoda were recorded. Most of the species collected were in small numbers and the majority occurred in more than one locality. The class Insecta was dominant in both density and diversity. The highest frequency of occurrence was shown by thysanuran *Thermobia* sp. And the tenebrionid beetle *Adesmia cancellata* L. The tenebrionid *Trachyderma hispida* Forsk. and the orthopteran acridid *Truxallis* sp. also had a wide distribution.

Relative density, relative frequency and relative biomass of the different species were assessed and shown in Table 3. The dominance value for each species; which is equal to the sum of the relative density, relative frequency and relative biomass, was computed and shown in (Fig. 2). The results indicate that all the arthropod species collected lie between 0 and 100% in the dominance scale of 0 to 300%. They are thus considered to be of rare occurrence. However, within this status the highest value is scored by *A. cancellata*, (82.47%) followed by *Thermobia* sp. (65.6%), *T. hispida* (57.42%), *Truxallis* sp. (50%), the lepidopteran *Tarucus rosaeus* Austant, and the isopteran *Porcellio evansi* Omer Cooper (41.6%). This indicates that the highest dominance value were scored by detrivore insects followed by two herbivore species and a detrivore terrestrial crustacean.

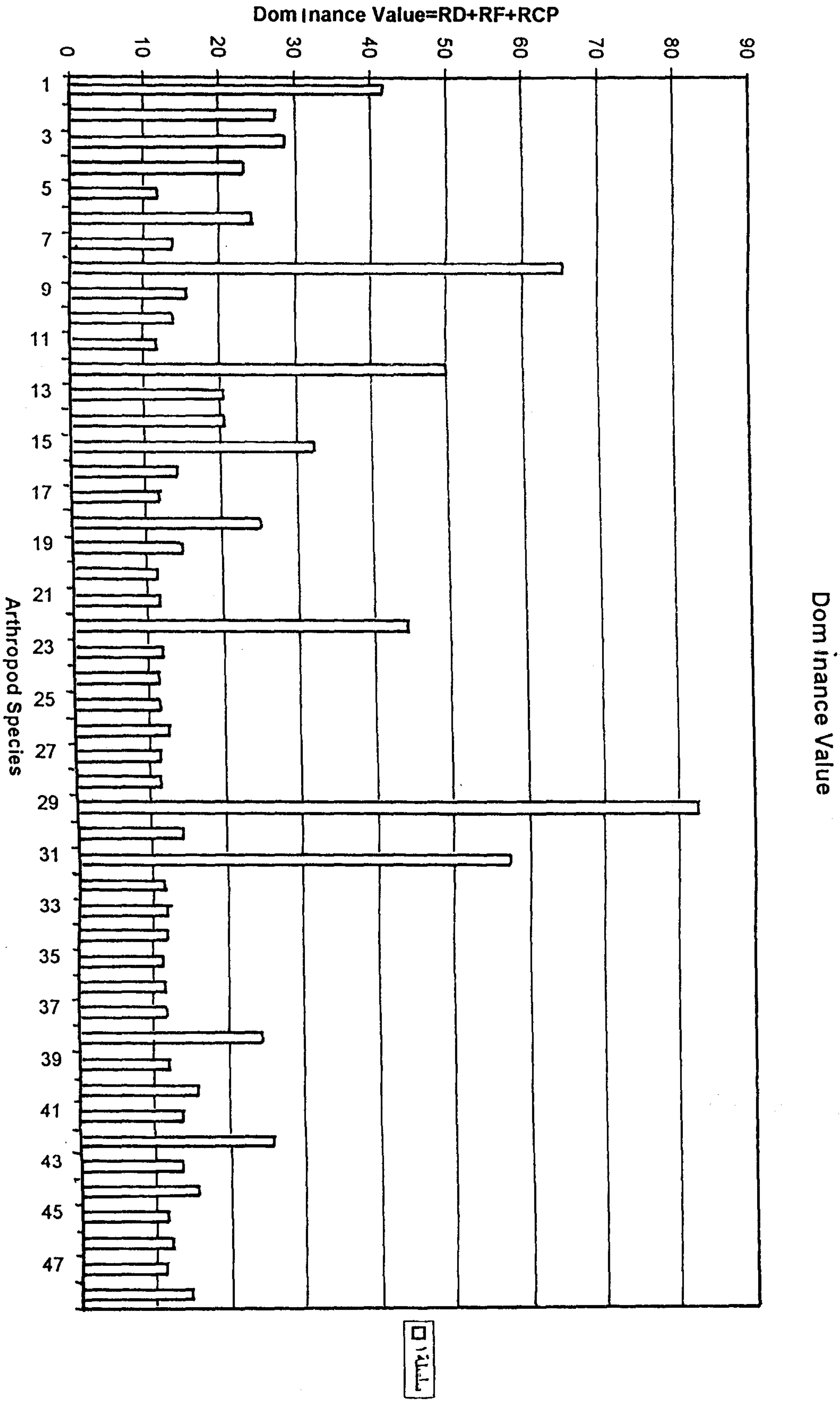

Fig. 2: Dominance values of arthropod species collected.

Plant biomass (g/m²), relative density (n/Nx100), diversity (using Simpson's index) and fresh weight (gm/100m²) of the arthropods are tabulated in Table 4. Correlations between plant biomass (independent variance) and arthropod relative density, diversity and biomass are respectively expressed as scatter diagrams and shown in (Fig. 3). The correlation coefficient (r) exhibits a weak positive correlation between plant biomass and arthropod relative density (r = +0.598). There is no correlation between plant biomass and either arthropod diversity or biomass; (r = -0.123 and -0.48 respectively). This indicates that the increase in plant production which might slightly enhance desert arthropod density does not readily affect arthropod diversity or biomass.

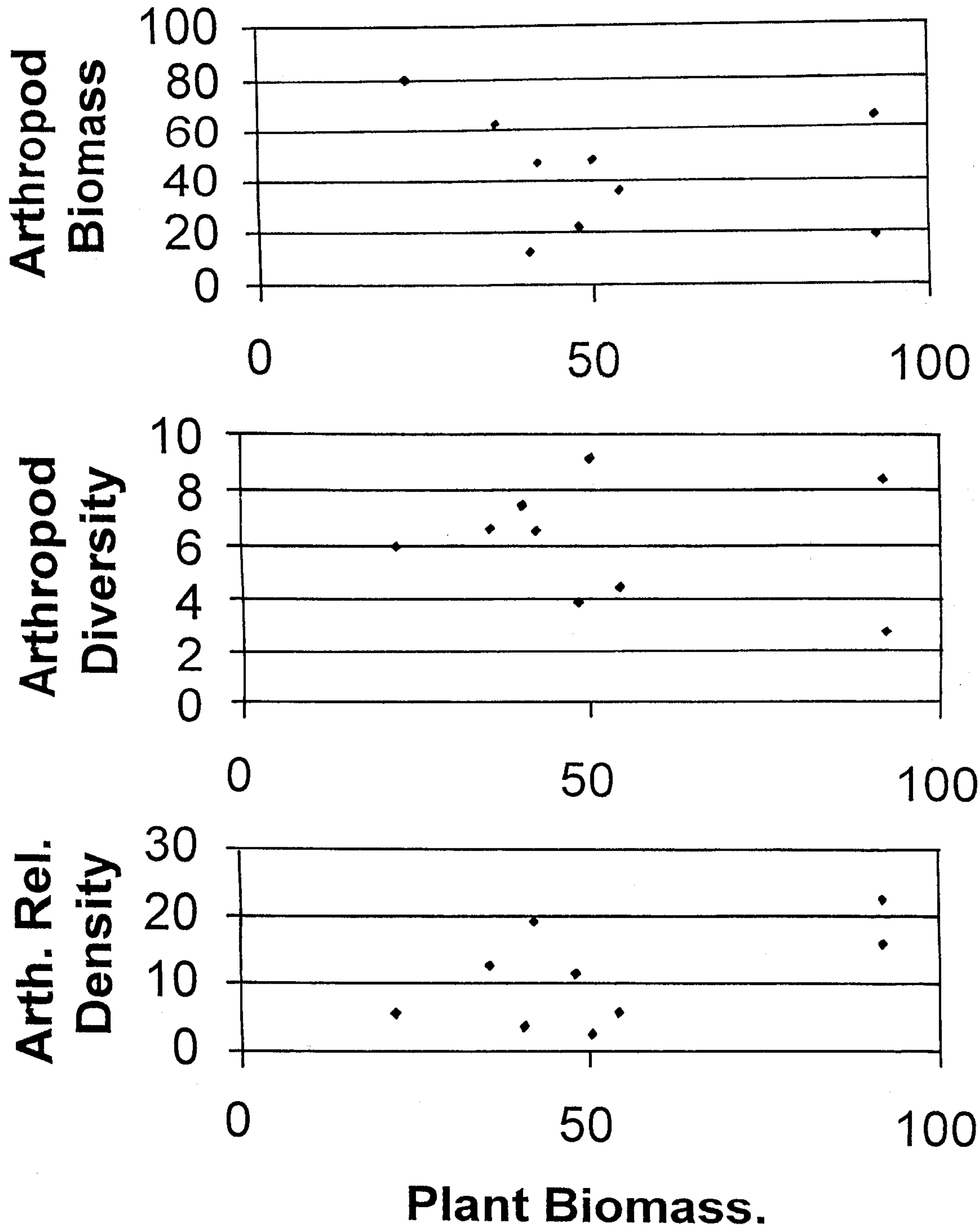

Fig. 3: Scatter diagram showing correlation between plant biomass and arthropod biomass, arthropod diversity and arthropod relative density.

The number of arlthropod species, individuals and the biomass of each of trophic levels of consumer (herbivores, carnivores and detrivores) are shown in Table, 5. The total values indicate that detrivores dominate in diversity and density, but come second to herbiovores in biomass. The ratios among herbiovores, carnivoes and detrivores are respectively 1:0.57:1.43 in diversity, 1:0.53:2.4 in density and 1:0.2:0.67 in biomass.

Cumulative plant biomass and the biomass of consumer arthropods are shown in Fig. 4. The pyramid of biomass looks symmetrical but herbiovores could only transfer 0.45% of the primary production available. Carnivores made use of about 20.5% of the herbivore biomass, while detrivores biomass represents the equivalent of 44% of the total herbivore and carnivore biomass and only 0.24% of plant biomass. This demonstrates that among desert arthropods herbivores exhibit low efficiency in energy transfer. Carnivores relatively enjoy higher and more stable efficiency. Detrivores on the other hand, are successful in making use of the richer food resources constituted of local and wind-blown plant and animal detritus material.

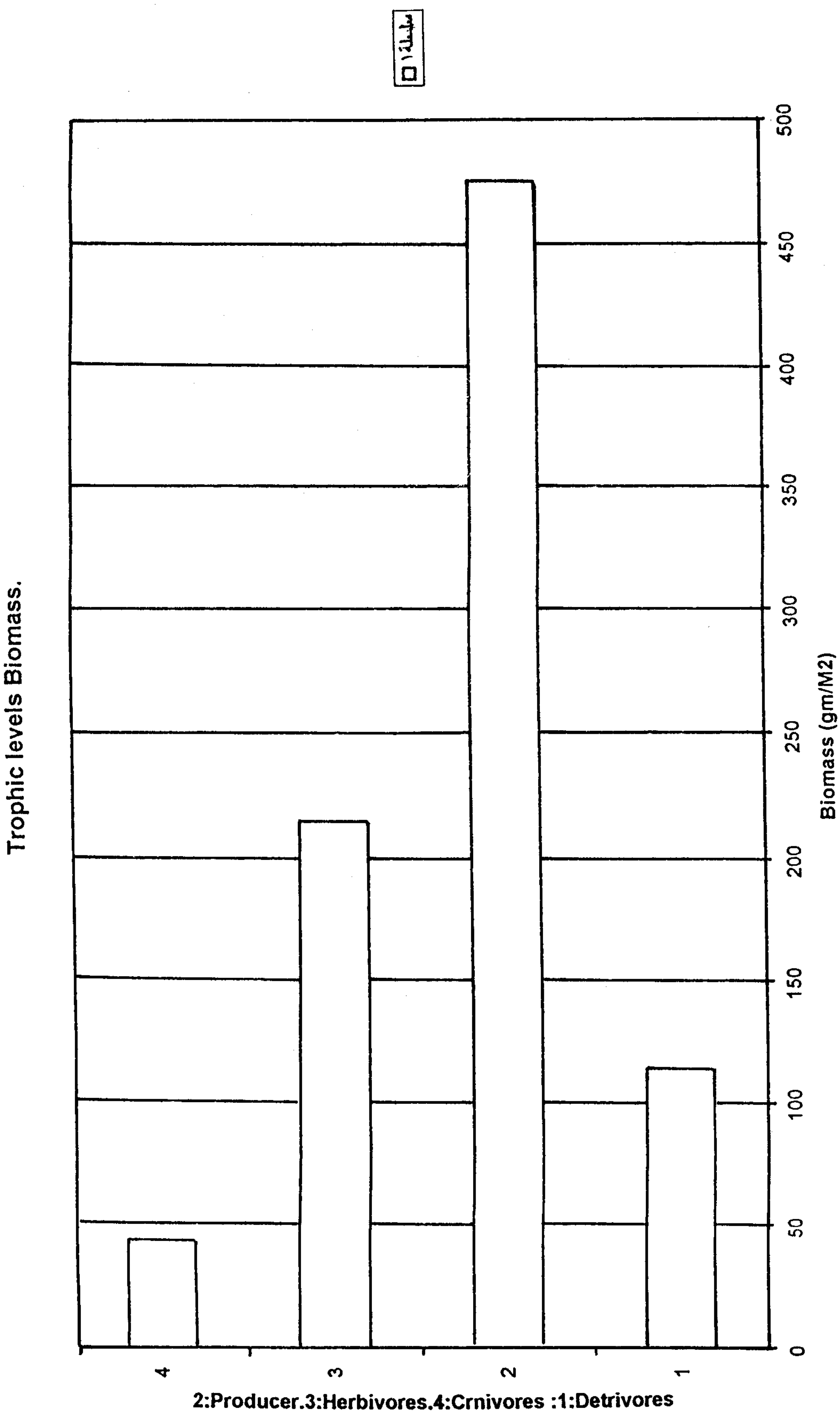

Fig. 4: Cumulative plant biomass and the biomass of consumer arthropods at different trophic levels.

Discussion

The principle driving force of the desert ecosystem is incoming moisture, which is characterized by being highly uncertain in space and time. This has both direct short-term effects on the consumers of ephemeral vegetation as well as more indirect long-term effects on carnivores and detrivores (10). Such effects become more pronounced in dry deserts such as the Qatari Desert: The present data indicate low numbers of arthropod species in samples from various habitats collected in summer or spring. Many of the species are of general and wide distribution. However, few species are habitat specific; the termite *Anacanthotermes ochracious* is restricted to alluvial soils of land-depressions, while the termite *Psammotermes hybostoma* is a sand-dune inhabitant. The butterfly *Tarucus rosaeus* restricts its activities and is only found around the desert bush *Ziziphus mallifera* (5). Crawford and Seely (6) showed that species richness and individual abundance were highly habitat specific among dunefield arthropods of the Namib Desert.

Judged by the 0-300% scale of dominance value, the arthropod species collected in this study lie within 0 - 100% zone, which indicates a low density and rareness. The highest dominance values are scored by two detrivores; the tenebrionid *A. Cancillata* and the thysanuran *Thermobia* sp. One herbivore, the grasshopper *Truxallis* sp. scored reasonably high dominance status. Carnivores maintained a low but stable value. It was also noted that the increase in plant production, which may slightly enhance desert arthropod density, does not readily affect arthropod diversity or biomass.

It seems that unsustained desert production, which occurs in pulses, in addition to the adverse physical conditions in dry desert, restrict the growth and capacity for development of desert arthropods. These show a very conservative respose to temporal increase in primary production. This is most probably a pay-off which enables them to escape competition and predation. detrivores have shown some success in community production making use of semi-permanent availability of local or wind transported organic detritus. This agrees with findings of Crawford and Seely (6) who reported that among Namib Desert dune field arthropod assemblages, individual numbers and total biomass were much greater for detrivores than for herbivores and carnivores. Crawford and Tayloer (1984) reported that many desert invertebrates are able to break down the organic materials ingested with aid of gut symbionts. This is a useful adaptation in extreme environments where the activity of decomposers in the soil is low.

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Table 1: Physical parameters and plant biomass in the study localities shown in Fig. 1

Locality	Date of visit	Time of day (hr)	Air temp. °C	% RH	Soil temp. °C (5-10 cmd)	Soil type	Soil moisture content	Soil organic matter content	Soil pH	Soil salt content	Wind speed m/hr	Plant biomass g/M
Rodat UMALAMAD	27-10-95	09:30	30	55	35	Sandy loan	0.72%	0.68%	7	0.12%	2	42
	11-4 -96	10:25	23	58	25	Sandy loan	3.42%	3.6%	7	0.11%	10-20	92
Rodat ALKARANA	14-10- 96	09:20	25.6	60	26.7	Sandy loan	0.48%	0.7	7	0.09%	2	40.5
GHARELBIRADE (sand dunces)	11 - 4- 96	10:15	29	72	32	loamy sand	2.5%	2.2	7	0.17%	50	37
Rodat ALFARAS	17- 10 - 96	11:30	34.4	30	34	Sandy loan	0.78%	6.63%	7.5	0.28%	< 2	48
ALIWANA (Sabkha)	17 - 10 -96	09:00	31.7	44	33.3	salty mud	7.4%	7.4%	8.06	3.94%	5	22
Rodat ALFARAS	3 - 4 - 97	10:00	24	50	26	sandy loam	5%	0.91%	8.06	0.3	30	92
ALIWANA (Sabkha)	3 - 4 - 97	11:30	25	45	26.5	salty mud	3.76%	0.09%	8.69	2.49	20	54

Table 2: Frequency, number of individuals and cumulative biomass of desert arthropods collected.

Class, Order & Family	Species	Frequancy of Occurance Out of 9 cases	Commulative No. in 100 m 2	Commulative Biomass In gm/ 100 m^2
Crustacea, Isopoda, Oniscidia	*Porcellio evansi* Omer Cooper	2	63	8.77
Chilopoda, Scalo pendramorpha	*Trachycomocephalus mirabilis* (Porat)	2	9	9.36
Arachnida, Scorpionida.	*Androctonus grassicauda* (Oliv.)	2	5	16.5
Arach., Aranaeae Gnathophosidae	*Zelotes simplex obscurior*, Denis	2	4	0.446
= Thomisidae	*Phillodronus Sp.*	1	2	0.618
= Lycosidae	*Lycosa sp.*	2	4	1.246
Arach., Acari, Ixodidae.	*Hylomma impeltatum, Schultze & Schlottke*	1	4	5.07
Insecta, Thysanura, Lipismidae.	*Thermobia sp.*	5	33	4.79
= Isoptera Hodotermitidae	*Anacanthotermes ochraeues*,(Burm)	1	15	1.8
== Rhinotermitidea.	*Psammotermes hybostoma*, Desn.	1	10	0.9
= Orthoptera Gryllidae	*Acheta domistica* L.	1	1	0.452
== Acrididae	*Truxallis sp.*	4	5	14.77
===	*Anacridium melanorhoden*, (Dirsh)	1	3	27.2
===	*Locusta migratoria* (Klug)	1	3	27.27
===	*Sphinognatus sp.*	1	1	9.09
= Dictyoptera Mantidae	*Empusa pennata* (Thumbrg)	1	1	2.08
= Neuroptera, Myrmeleontidae	*Grelion sp.*	2	10	1.35
= Hemiptera, Pentatomidae.	*Nazara viridula*, (Lin.)	1	12	1.8
== Lygaedae	*Dieuches armipes* (Fab.)	1	1	0.2
= Lepidoptera, Pieridae	*Anaphais aurata* (Fab.)	1	2	0.44

Table 2: (cont)

===	*Tarucus rosaeus,* Austant	3	36	6.28
= Diptera, Chaliphoridae.	*Chrysomia albiceps,* Weid.	1	3	0.62
== Asilidae	*Apoclea femoralis*, Wied.	1	1	0.132
==Syrphidae	*Eumerus taremenorium.*	1	1	0.14
= Hymeoptera, Formicidae	*Cataglyphis niger*, (L.)	1	5	0.5
===	*Monomorium sp.*	1	1	0.034
== Pompilidae.	*Stoidia noscibilis* (Pallas)	1	1	0.74
= Coleoptera Tenebrionidae	*Adesmia cancellata* L.	5	47	46.34
===	*Adesmia clathrata* (Sol.)	1	5	5.3
===	*Trachyderma hispida* Forsk.	4	19	25.4
===	*Blaps mortisaga* Sol.	1	1	0.545
===	*Pimelia arabica* Klug.	1	2	0.576
===	*Prionotheca coronata* (Oliv.)	1	2	1.2
===	*Akis eleata* (Sol)	1	1	0.28
===	*Zophosis* sp.	1	1	0.175
===	*Pimelia intervallaris* (Kaszab)	1	1	0.288
===	*Mesostina arabica* (Gestro)	2	6	1.28
===	*Erodius* sp.	1	3	0.39
== Carabidae	*Callosoma imbricata* Clug	1	11	5.78
===	*Callosoma deserticola* (Sem)	1	6	3.16
===	*Thermophilum duedecimguttatum* (Bon)	2	5	7.58
== Dermestidae	*Dermestes frischi* (Kugelann)	1	7	2.34
== Coccinellidae	*Coccinella septempunctata* L	1	12	3.8
== Cicindelidae	*Cicindela memoralis* (Oliv)	1	1	0.28
== Meliodae	*Cylidrothorax buettikeri* (Kasz.)	1	1	0.52
== Hydrophilidae	*Laccbius* sp.	1	1	0.32
== Scarabidae	*Scarabaeus sacer anticollis* (Mot.)	1	4	7.72

Table 3: Dominance values of arthropod species collected.

Arthropod SPECIES	Relative Density= n/Nx 100	Relative Frequancy= f/Fx100	Relative Biomass b/Bx100	Dominance Value= RD + RF + B (out of 300)
Procillio evansi	16.45	22.2	2.78	41.6
Trachymocephalus mirabilis	2.3	22.2	2.97	27.4
Androctonus grassicauda	1.3	22.2	5.23	28.7
Zelotes simplex obscurior	1.04	22.2	0.14	23.3
Philodronus sp.	0.52	11.1	0.196	11.8
Lycosa sp.	1.04	22.2	0.39	24.1
Hylomma impellatum	1.04	11.1	1.6	13.7
Thermobia sp.	8.6	55.5	1.5	65.6*
Anacanthotermes ochraceus	3.9	11.1	0.75	0.75
Ps samotermes hybostoma	2.6	11.1	0.29	14
Acheta domestica	0.26	11.1	0.14	11.5
Truxallis sp.	1.3	44.1	4.6	50*
Anacridium melanorhoden	0.78	11.1	8.6	20.4
Locusta migratoria	0.78	11.1	8.6	20.4
Conocephala sp.	2.6	11.1	18.7	32.4
Sphinognatus sp.	0.26	11.1	2.8	14.14
Empusa pennata	2.6	11.1	0.66	12
Gelion sp.	3.13	22.2	0.44	25.25
Nazara viridula	2.6	11.1	0.57	14.9
Dieuches armipes	0.26	11.1	0.06	11.42
Anaphes aurata	0.52	11.1	0.14	11.76
Tarucus rosaeus	9.4	33.3	1.99	44.69
Chrysomia sp.	0.78	11.1	0.196	12.07

Table 3: (cont)

Apoclea femoralis	0.26	11.1	0.04	11.4
Eumerus taremenorium	0.26	11.1	0.04	11.4
Cataglyphis niger	1.3	11.1	0.158	12.6
Monomorium pharraonsis	0.26	11.1	0.11	11.47
Stolidia noscibilis	0.26	11.1	0.23	11.59
Adesmia cancellata	12.27	55.5	14.7	82.47**
A. clathrata	1.3	11.1	1.68	14.08
Trachyderma hispida	4.95	44.4	8.06	57.42*
Plaps mortisaga	0.26	11.1	0.173	11.5
Pimelia arabica	0.52	11.1	0.183	11.8
Prionotheca coronata	0.52	11.1	0.38	12
Akis elevata	0.26	11.1	0.09	11.45
Zophosis sp.	0.26	11.1	0.06	11.42
Pimelia intervallaris	0.26	11.1	0.09	11.45
Mesostina arabica	1.56	22.2	0.41	24.17
Erodius sp.	0.78	11.1	0.123	12
Callosoma imbricata	2.87	11.1	1.8	15.17
C. deserticolla	1.57	11.1	1.0	13.67
Thermophillum duodecimguttatum	1.3	22.2	2.4	25.9
Dermestid frischi	1.8	11.1	0.74	13.6
Coccinella septempunctata	3.13	11.1	1.2	15.43
Cicindella memoralis	0.26	11.1	0.09	11.45
Cylindrothorax buettikeri	0.26	11.1	0.165	12
Laccabius sp.	0.26	11.1	0.1	11.47
Scarabaeus sacer anticollis	1.04	11.1	2.45	14.59

Table 4: Plant biomass in relation to arthropod density, diversity and biomass.

Locality & Month	Pl. Biom. (gm/m2)	Anim. Rel. Dens. (n/Nx100)	Anim. Div. (Sim., s. Ind)	A. Bm. ($gm/100m^2$)
Rodat um Alamad				
October	42	19.25	6.6	47.18
April	92	22.7	2.81	19.2
Rodat Alkaraana				
October	40.5	3.96	7.5	12.77
Ghar Elbirade Sand dunes				
October	35.5	12.83	6.67	62.47
April	50	2.7	9.16	48
Rodat Alfaras				
October	48	11.35	3.96	22.3
April	92	16	8.5	65
Sabkhat Aliwana				
October	22	5.5	6	80.54
April	54	5.8	4.5	36

Table 5: Number of species, of individuals and cumulative biomass of arthropods at different trophic levels.

Locality & Month	**No. of Sps. (100m2)**	**No. of Individs. (100m2)**	**Biomass (gm/100m2)**
Rodat Um Alamad			
October	12(4H, 4C&4D)	78(21H, 12C&45D)	47(7H, 13C&27D)
April	6 (2H, 1C&3D)	92 (19H, 11C&62D)	19 (6H, 6C&7D)
Ghar Elbirade Sand dunes			
October	15(2H, 3C&1D)	52(3H, 8C&41D)	62(29H, 11C&22D)
April	7 (6H, 1C&0D)	11 (10H, 1C&0D)	48 (47.9H, 0.1C&0D)
Rodat Alkaraana			
April	10(3H, 1C&6D)	16 (3H, 6C&7C)	13 (6H, 3C&4C)
Rodat Alfaras			
October	6 (2H, 1C&3D)	46 (22H, 5C&19D)	23 (9H, 1C&13D)
April	11(3H, 2C&6D)	65 (9H, 6C&50D)	65 (30H, 8C&27D)
Sabkhat Aliwana			
October	6(3H, 1C&2D)	22(12H, 1C&9D)	80(70H, 2 C&8 D)
April	5(1H, 1C&3D)	12(1H, 3 C& 8D)	16 (9 H, 1 C& 6 D)
Total	78(26H, 15C&37D)	394(100H, 53C,241H)	373(215H, 44C, 144D)

H stands for Herbivore

C stands for Carnivore

D stands for Detrivore