PREVALENCE OF ECTOPARASITES AND THEIR EFFECT ON SOME BIOCHEMICAL INDICES IN CAMELS (CAMELUS DROMEDARIUS) AT SHALATIN CITY
(With 10 Tables and 7 Figures)

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انتشار الطفيليات الخارجية وتاثيرها على بعض المؤشرات البيولوجية
في الجمل (نادي النمر) في مدينة شالاتين

عمرو محمد مهراخ، مصطفى أحمد صالح

After conducting a detailed study on the prevalence of external parasites and their effect on some biochemical indices in camels (CAMELUS DROMEDARIUS) at Shalatin City, the authors reported significant findings. The study involved 10 tables and 7 figures to illustrate the results. The presence of external parasites was noted, and their impact on biochemical indices was analyzed.
SUMMARY

Field and abattoir survey was done on a total of 810 male and female camels at different ages and seasons to study the prevalence of ectoparasites at Shalatin City, Red Sea Governorate, Egypt. Out of 810 examined camels in the field study, 45.59% revealed infestation with ectoparasites. Of these animals 11.76% were infested with sarcoptic sebobic var camel, 30.14% with ticks and 3.67% showed mixed infestation. The incidence of ectoparasites in the abattoir survey was higher (87.7%) because of the high incidence of Cephalopros tillettorum (67.5%). Tick species like Hyalomma dromedarii, Amblyomma lepidum and Oriblyomma savignyi species were recorded. Older camels were more susceptible than younger individuals. Mange mites and bot flies were more prevalent with higher intensity in females than male camels, meanwhile tick infestation was more prevalent in males but females had higher burden. Contrarily to ticks, the highest rate of mites and nasal bot infestation was recorded in winter while the lowest was in summer. Normocytic normochromic anaemia was the hallmark of tick and nasal bot infestation, but infestation with mites revealed microcytic hypochromic anaemia. All infected groups showed leucocytosis accompanied by lymphocytosis and eosinophilia. Proteinogram showed hypoproteinaemia consequent to hypoalbuminaemia and hyperglobulinaemia. There was marked hyper a-globulinaemia and hyper γ-globulinaemia without changes in β-globulin fraction. Cases of sarcoptic mange treated with ivermectin showed disappearance of the initial clinical signs and restored haematological and biochemical indices.

Key words: dromedary, ectoparasites, prevalence, protein lecithophoroclastic.

INTRODUCTION

The ectoparasitic fauna of the animals consists of two zoological classes, the Arachnida (mange mites and ticks) and the Insecta (insects), within the phylum Arthropoda (Soulsky, 1982 and Urquhart et al., 1986). Mange is the most feared and widespread disease affecting the camel second to Surra (Higgs, 1986). Because the disease is highly contagious, obstrusive, debilitating and zoonotic, it is one of the two diseases, which cause severe economic losses, and camel herdsmen investability seek modern veterinary treatments.
Like helminthiasis, ticks also play a major role in morbidity and mortality especially in young camels because of their role as an intermediate host for many tick borne diseases and harbouring of several viruses and rickettsias of biomedical and zoonotic importance (Pagrum and Higgins, 1992).

The non-arthroitic ectoparasites of camels are the insects. The Oestridae (naso fies) is a highly specialized family in which the adult mouth part is non-functional but the larvae are obligatory parasites. The camel nasal bot fly (Cephalopinus trillator) is host specific. The larvae of this fly are deposited in the nostrils, nasopharynx and nasal sinuses resulting in upper respiratory distress sets (Musa, et al., 1989; Pagrum and Higgins, 1992; Patani and Khalil, 1994; Mosty, et al., 1998 and Zayed, 1994).

Studies on the prevalence of camel ectoparasites are world widespread (Higgins, 1984 and 1986; Abbas et al., 2000; Al-Ruwashdeh et al., 2000; Balasubramaniam et al., 2001 and Muhammad et al., 2001) but unfortunately, it had not been fully established under the Egyptian conditions.

On the other hand, the effect of these ectoparasites on the general health of camels had not yet been recognized. To relate ectoparasite infestations with performance consequences of the host, specific indices are required. Blood serum proteins including albumin and total globulin were evaluated during mange mite infestation in camels (Rahman, et al., 2002), but not in animals infected with other ectoparasitic infestation.

Despite of its importance as an indicator for the general health (Thomas, 2000a,b), the electrophoretic pattern of blood serum proteins in camels and unfortunately in other ruminants infected with ectoparasites was neglected and had not been fully established. Therefore, the present work was designed to throw the light on the prevalence of ectoparasites affecting camels at Shalatin City and the effect of those parasites on clinical and some haematological parameters of camels. In addition, to evaluate the electrophoretic pattern of blood serum proteins during ectoparasitic infestation of camels with trials of treatment.

**MATERIALS and METHODS**

The study area: Shalatin City, Red Sea Governorate, Egypt, is a desert area, which represent the southern part of the eastern desert and is considered one of the southern borders of Egypt. Exported camels from
eastern Sudan are passed through this area. The total number of camels in this area is about 40 thousands, of a total 133 thousands camels present in Egypt (GOVS, 1998).

Animals
1- Field survey: a total of 680 male and female camels at different ages were subjected to careful examination for ectoparasitic infestation during the period from January to December 2003. A complete clinical examination was carried out on these animals according to Higgins (1985).
2- Abattoir survey: was done on a total of 130 male and female camels at different ages, which slaughtered at Shalatin abattoir.

Sampling
1- Parasitological sampling:
a- Ticks were collected by detachment of different types of ticks from different parts of the body by the help of forceps without damaging the mouth parts. All ticks were preserved in 70% alcohol. Sites of ticks and number were recorded. Identification of ticks was done according to Hoogstraal (1978) and Soulsby (1982).
b- Skin scraping was done at the edge of the suspected active mange lesions by the help of sharp scalpel in a test tube. The collected parts were processed for mites examination by maceration methods (Coles, 1986). Identification of mites was carried out after Soulsby (1982).
c- Collection of Cephalotachinus titillator larvae: The frontal oronasal region of the head of slaughtered camels was opened at the abattoir to reach the prenasal siles of C. titillator in the anterior and posterior chambers of the naso-pharynx. The different stages of larvae were removed, counted and identified on the bases of measurement given by Soulsby (1982), Higgins (1984) and Urquhart et al. (1986).
2- Blood sampling: A total of forty male camels (4-6 years) were used for blood sampling. These animals were proved to be free from internal and blood parasites (by examination of their feces and blood smears according to Coles, 1986) and had normal rectal temperature to exclude other bacterial or viral diseases. Thirty of these camels were classified into 3 groups (10 each) each one was headly infested with only one ectoparasite species, either tick, mange or C. titillator. The rest (10 camels) were clinically healthy parasites-free group, which used as control. Two blood samples were drained from each camel. In C. titillator infested group sampling was carried out from suspected camels in labeled tubes before slaughtering which was confirmed after postmortem examination of the nasopharynx. In mite infected mares,
sampling was carried out just before and four weeks after beginning of
treatment. The first blood sample contained anti-coagulant, used for
The second one used to obtain serum for biochemical determination of
total protein and protein electrophoretogram.
Total serum protein was measured after the methods described
by Henry et al. (1974). Protein electrophoretogram was carried out by
using Titan III cellulose acetate plate at pH 8.8 at ionic strength of 0.037,
saturated with Ponceau S dye and scanned by autodensitometer
(Horiba, Laboratories, Car. 1023) at absorption peak of 525 nm according
to manufacturer instruction.

Therapeutic applications:

Many camels were injected subcutaneously with 0.2mg/kg BW
(1st commercial solution/50kg BW) ivermectin (MSD AGVET Merek
& Co. Inc. Whitehouse Station, N.J., USA) twice with 15 days in
between. Tick infested camels and the surrounding area were sprayed
with diluted diazenon ((Neocticol, Hindustan Ciba Geigy Ltd.) at a rate
of 1:1000 three times with two weeks interval.

RESULTS

Clinical signs: Many animals showed marked irritation and they were
scratching and rubbing their bodies against objects. Lesions caused
intense itching, hypersensitivity, erythema and pruritus. Papules appear
and enlarge peripherically and coalesce with other lesions so that very
large areas of the affected skin were appeared. The hair was lost and the
skin was covered with chalky scales and became corrugated, thickened,
lumminated and ened into deep fissures. These fissures were cooling
sero-haemorrhagic exudates (Plate 1). The preferable predilection sites of
these lesions were the axillae, inguinal regions, brisket, neck, around the
root of the tail and on the face. In severely affected cases the legs were
noticed to be swollen and oedematos and the animal lost appetite and
became debilitated.

Ticks infested camels showed severe irritation, restlessness, and
itching, which resulted in the damage of hides and traumatic injuries due
to tick bites. Camels were severely dechilivated, weak and exhausted, and
the owners had a complaint of distraction from eating and loss of
production. Manifestations of anaemia including paleness of the visible
mucous membranes were also clear on these animals.
Plate 1: Clinical signs of mange infestation in camel.  
A. on the thighs, B. on the back and abdomen, C. on the neck.

Plate 2: Tick infestation in the nose of camel.  
A. In the live animal, B. After P.M. examination.
The predilection sites of ticks on these camels were the soft regions including the perineal, inguinal and axillary regions in addition to the inner sides of the ear, within the nostrils and around the eyes (Plate 2).

Camels infected with *C. titillator* showed restlessness, irritation, sneeze, snort, difficult breathing, neurological signs, anaesthesia and debility. The larvae may be sometimes expelled after a great deal of scouring. In the abattoir, these camels showed swollen, haemorrhagic and oedematous mucous membranes of the nasopharynx and nodules with central abscesses and fuel of calcification at the sites of larval attachment. Occasionally, degenerated larvae were found embedded between the turbinate bones. The nasal cavity was congested and filled with mucus in which some larvae were entangled (Plate 3).

![Plate 3: Cephaloprena titillator in the nasopharynx of camel](image)

**Parasitological findings:**

**Field study:** out of 680 examined camels, 310 (45.59%) revealed infestation with ectoparasites. Of these infested animals, 80 (11.76%) were infested with mange mites, 205 (30.14%) were infested with ticks and 25 (3.67%) showed mixed infestation by mange and ticks (Tab. 1 and Fig. 1).

**Abattoir survey:** out of 130 slaughtered camels, 114 (87.7%) were infested with ectoparasites. Of these camels, 88 (67.69%) were infested by *C. titillator* larvae, 15 (11.54%) were infested by ticks and 11 (8.46%) showed mixed infestation by *C. titillator* larvae and ticks (Tab. 2 and Fig. 2).
Plate 4: Tick species: A. male Amblyomma americanum dorsal view (x 5), B. male Hyalomma dromedarii dorsal view (x 5), C. male Amblyomma americanum ventral view (x 5), D. male Hyalomma dromedarii ventral view (x 5), E. Female Ornithodoros savignyi dorsal view (x 2), F. Female Hyalomma dromedarii (x 2).

Plate 5: Tick mouthparts: A. Ventral anterior end of O. savignyi (x 10) showing mouthpart, B. Mouthpart of Amblyomma americanum dorsal view (x 15), C. Mouthpart of male Hyalomma dromedarii dorsal view (x 15).
Identification of investigated ectoparasites:
1- Mange mites. Sarcoptes scabiei var. camelli was the only species recorded in this work (Plate 6A). Mites were characterized by terminal eyes, short legs not extended past body margin and suckers on long unjointed stalk.
2- Ticks during the present investigation, Erythromma dromedarii, Amblyomma lepidum and Ornithodoros savignyi species were recorded. Identification according to ventral and dorsal surfaces in addition to mouthparts of the examined tick is shown in plate (4&5). H. dromedarii was characterized by presence of eyes, hypostome and palp long. In males there was a pair of adanal shields and some times accessory adanal shields. Spiracles were triangular in females. A. lepidum was manifested by clear ornamented somum without adanal shields. The mouth parts were found anteriorly and the eyes were small dark hemisphere. There were 6-8 partially pigmented fatsoons. O. savignyi were characterized by presence of eyes.

Plate 6: A- Mange mite, Sarcoptes scabiei var. camelli (x100)  
B- C. titillator larvae x1.5 showing 1st, 2nd and 3rd stages.  
C- C. titillator posterior dorsal view (x5)  
D- C. titillator posterior dorsal view (x5). Anterior dorsal view  
E- C. titillator posterior dorsal view.
The dorsal and ventral surface of the body do not meet at the sharp lateral margin. Body surface roughened by tiny protuberances called mammillae.

3. Cephalopine tillitator: after slaughtering, the larvae were found embedded in the mucous membranes and fill the cavity spaces of the nasopharynx (Plate 3). The larvae (Plate 6 B, C, D, E) were elongated white or slightly yellowish in colour with tapered anterior and flat posterior ends. Pair of small dark coloured oral hooks was present in the anterior. The posterior end had dark brown pea shaped genital plates. The ventral surface of these larvae presented scattered spines but their last segment had several rows of such spines. The first, second and third stage larvae were identified (Plate 5). The larval burden varied from 9 in light infected to 80 in heavily infected camels with a mean of 45 ± 1.4 larvae per camel.

The effect of age, sex and season on the prevalence of ectoparasites.

The effects of age and sex of camels in addition to the effect of different seasons of the year on the distribution of ectoparasites and their prevalence are presented in tables 2, 6, 5, 6 and 7 and figures 3 - 5.

The effect of ectoparasitic infestation on the haemogram and leucogram of camels:

Camels infested with ectoparasites showed significant reduction in the mean values of total erythrocyte count, haemoglobin concentration and packed cell volume. Consequently, there was normocytic normochromic anaemia in tick and C. tillitator infested camels while mange infestation resulted in microcytic hypochromic anaemia, which was denoted by the reduced values of the mean corpuscular volume (MCV) and the mean corpuscular haemoglobin (MCH) as shown in table 8 and Figure 6. Leucogram of infested camels revealed leucocytosis accompanied by lymphocytosis and eosinophilia (Table 9 and Fig. 6).

The profile of blood serum protein during ectoparasitic infestation in camels:

Camels infested with ectoparasites showed marked hypoproteinemia, hypoglobulinaemia and hyperglobulinaemia. Globulin fractionation revealed hyper-alphaglobulinaemia, and hyper-gammaglobulinaemia. Beta-globulin region remained constant and did not differ than control animals. Albumin / globulin ratio was significantly decreased in parasite infested camels if compared with healthy individuals (Table 10 and figure 7 & 8).
Fig. 1: A field survey showing the prevalence of ectoparasites in camels at Shalatin City.

Fig. 2: An abattoir survey showing the prevalence of ectoparasites in camels at Shalatin City.

Fig. 3: The effect of age and sex on the rate of mites infestation in camels at Shalatin City.

Fig. 4: Seasonal variations of ectoparasitic infestation in camels at Shalatin City.
Fig. 5: The effect of age and sex on the rate of bot fly infestation in camels at Shalatin City.

Fig. 6: Haematological picture (means ±SD bar) in co-parallel infected camels. *P* values indicate the probability level of significance than control group of each category.

Fig. 7: Blood serum protein profile (means ±SD bar) in co-parallel infected camels. *P* values indicate the probability level of significance than control group of each category.
Effect of treatment:

One month after beginning of treatment of mangy camels, the clinical signs disappeared and there was restore of the haematological and biochemical indices (Tables 8, 9&10).

Table 1: A field survey showing the prevalence of octoparasites in camels at Shalatin City.

<table>
<thead>
<tr>
<th>No. examined camels</th>
<th>Males</th>
<th>No.</th>
<th>%</th>
<th>Ticks</th>
<th>No.</th>
<th>%</th>
<th>Mixed</th>
<th>No.</th>
<th>%</th>
<th>Total</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>680</td>
<td>581</td>
<td>82.7</td>
<td>157 60.66 22 31.81 34 51.49</td>
<td>12.2</td>
<td>2 5.00</td>
<td>8 11.90</td>
<td>210 45.59</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: The effect of age, sex and season on the rate of octoparasites infestation in camels at Shalatin City aristick.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Examined camels</th>
<th>Ticks</th>
<th>Mixed</th>
<th>Ticks</th>
<th>Mixed</th>
<th>Ticks</th>
<th>Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>390</td>
<td>114</td>
<td>87.7</td>
<td>117</td>
<td>14</td>
<td>16.2</td>
<td>11.1</td>
</tr>
<tr>
<td>Effect of age:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-5 year</td>
<td>60</td>
<td>45</td>
<td>75.0</td>
<td>17</td>
<td>61.66</td>
<td>8</td>
<td>50.0</td>
</tr>
<tr>
<td>6-10 year</td>
<td>45</td>
<td>35</td>
<td>77.8</td>
<td>22</td>
<td>71.15</td>
<td>4</td>
<td>6.66</td>
</tr>
<tr>
<td>11-15 year</td>
<td>25</td>
<td>26</td>
<td>100.0</td>
<td>19</td>
<td>76.00</td>
<td>3</td>
<td>12.0</td>
</tr>
<tr>
<td>Effect of sex:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>85</td>
<td>72</td>
<td>85.3</td>
<td>57</td>
<td>61.55</td>
<td>9</td>
<td>10.6</td>
</tr>
<tr>
<td>Female</td>
<td>45</td>
<td>42</td>
<td>93.3</td>
<td>31</td>
<td>68.89</td>
<td>6</td>
<td>13.3</td>
</tr>
<tr>
<td>Effect of season:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>45</td>
<td>37</td>
<td>82.2</td>
<td>32</td>
<td>71.11</td>
<td>3</td>
<td>6.66</td>
</tr>
<tr>
<td>Spring</td>
<td>30</td>
<td>28</td>
<td>93.3</td>
<td>22</td>
<td>73.33</td>
<td>4</td>
<td>13.33</td>
</tr>
<tr>
<td>Summer</td>
<td>25</td>
<td>22</td>
<td>88.0</td>
<td>15</td>
<td>60.00</td>
<td>4</td>
<td>16.0</td>
</tr>
<tr>
<td>Autumn</td>
<td>30</td>
<td>26</td>
<td>86.7</td>
<td>19</td>
<td>63.33</td>
<td>4</td>
<td>13.33</td>
</tr>
</tbody>
</table>

176
Table 3: Distribution of different tick species on the common predilection sites of camels.

| Tick species  | Neck | Ear | Neck and auditory | Perineal and inguinal | Saddle
|---------------|------|-----|-------------------|-----------------------|------
| No. | %    | No. | %    | No. | %    | No. | %    | No. | %    | No. | %    |
| Hyalomma anatolicum | 176 | 25.0 | 202 | 29.7 | 155 | 23.75 | 139 | 22.25 | 160 |
| Amblyomma equidae | 28 | 13.6 | 31 | 14.9 | 34 | 16.67 | 33 | 14.5 | 160 |
| Dermacentor reticulatus | -   | -   | 6   | 7.5 | 30 | 33.33 | 61 | 61.25 | 80  |

Table 4: The effect of age and sex on the rate of mange mite infestation in camels at Shalatin City.

<table>
<thead>
<tr>
<th>Age group</th>
<th>No. of examined camel</th>
<th>No. of infested camel</th>
<th>% of infested camel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1-5 year</td>
<td>1-10 year</td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Male</td>
<td>Female</td>
<td>Total</td>
</tr>
<tr>
<td>280</td>
<td>170</td>
<td>110</td>
<td>280</td>
</tr>
<tr>
<td>310</td>
<td>190</td>
<td>120</td>
<td>310</td>
</tr>
<tr>
<td>400</td>
<td>220</td>
<td>180</td>
<td>400</td>
</tr>
</tbody>
</table>

Table 5: The effect of season on the rate of mange mite infestation in camels at Shalatin City.

<table>
<thead>
<tr>
<th>Season</th>
<th>No. of examined camel</th>
<th>No. of infested camel</th>
<th>% of infested camel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>180</td>
<td>170</td>
<td>267</td>
</tr>
<tr>
<td>Spring</td>
<td>175</td>
<td>160</td>
<td>162</td>
</tr>
<tr>
<td>Summer</td>
<td>350</td>
<td>260</td>
<td>146</td>
</tr>
<tr>
<td>Autumn</td>
<td>355</td>
<td>120</td>
<td>74</td>
</tr>
<tr>
<td>Total</td>
<td>680</td>
<td>665</td>
<td>466</td>
</tr>
</tbody>
</table>

Table 6: Prevalence and seasonal variations of tick infestation of camels at Shalatin City.

<table>
<thead>
<tr>
<th>Season</th>
<th>No. of examined camel</th>
<th>No. of infested camel</th>
<th>Male camel</th>
<th>Female camel</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>180</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>340</td>
</tr>
<tr>
<td>Spring</td>
<td>175</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>320</td>
</tr>
<tr>
<td>Summer</td>
<td>350</td>
<td>260</td>
<td>260</td>
<td>260</td>
<td>520</td>
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<tr>
<td>Autumn</td>
<td>355</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>240</td>
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<tr>
<td>Total</td>
<td>680</td>
<td>665</td>
<td>665</td>
<td>665</td>
<td>1330</td>
</tr>
</tbody>
</table>
### Table 7: The effect of age on the rate of tick infestation in camels at Shalitin City.

<table>
<thead>
<tr>
<th>Age group</th>
<th>No. of inspected camels</th>
<th>No. of infected camels</th>
<th>% of infected camels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 year</td>
<td>250</td>
<td>55</td>
<td>21.15</td>
</tr>
<tr>
<td>6-10 year</td>
<td>310</td>
<td>85</td>
<td>27.42</td>
</tr>
<tr>
<td>11-15 year</td>
<td>110</td>
<td>68</td>
<td>61.82</td>
</tr>
<tr>
<td>Total</td>
<td>670</td>
<td>212</td>
<td>31.41</td>
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### Table 8: Some hematological parameters in ectoparasite-infested camels.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Healthy control camels</th>
<th>Tick-infested camels</th>
<th>C. bovis-infested camels</th>
<th>Before treatment</th>
<th>After treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC count</td>
<td>x 10^9</td>
<td>8.8 ± 0.57</td>
<td>6.19 ± 0.37</td>
<td>5.79 ± 0.44</td>
<td>7.67 ± 0.68</td>
<td>8.12 ± 0.15</td>
</tr>
<tr>
<td>Hemoglobin</td>
<td>g/dL</td>
<td>10.4 ± 0.23</td>
<td>9.0 ± 0.33</td>
<td>6.18 ± 0.44</td>
<td>7.25 ± 0.35</td>
<td>9.20 ± 0.42</td>
</tr>
<tr>
<td>PCV</td>
<td>%</td>
<td>31.21 ± 4.31</td>
<td>21.10 ± 6.05</td>
<td>21.90 ± 3.88</td>
<td>24.90 ± 4.20</td>
<td>28.10 ± 4.17</td>
</tr>
<tr>
<td>MCV</td>
<td>fl</td>
<td>23.8 ± 5.22</td>
<td>22.9 ± 5.09</td>
<td>22.3 ± 2.84</td>
<td>25.8 ± 4.25</td>
<td>34.61 ± 3.12</td>
</tr>
<tr>
<td>MCH</td>
<td>pg</td>
<td>12.50 ± 2.71</td>
<td>11.15 ± 2.55</td>
<td>11.57 ± 2.80</td>
<td>10.12 ± 3.64</td>
<td>12.12 ± 3.87</td>
</tr>
</tbody>
</table>

* Values are significantly differing than control at P< 0.05.

### Table 9: Leucogram of ectoparasite-infested camels.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Healthy control camels</th>
<th>Tick-infested camels</th>
<th>C. bovis-infested camels</th>
<th>Before treatment</th>
<th>After treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>WBC count</td>
<td>x x10^9</td>
<td>14.16 ± 1.23</td>
<td>16.74 ± 1.46</td>
<td>15.07 ± 2.54</td>
<td>15.07 ± 2.25</td>
<td>16.73 ± 3.72</td>
</tr>
<tr>
<td>Neutrophils</td>
<td>%</td>
<td>43.12 ± 4.41</td>
<td>38.10 ± 6.65</td>
<td>39.07 ± 4.52</td>
<td>38.23 ± 6.30</td>
<td>41.08 ± 4.56</td>
</tr>
<tr>
<td>Lymphocytes</td>
<td>%</td>
<td>47.61 ± 4.58</td>
<td>51.31 ± 3.56</td>
<td>50.14 ± 3.26</td>
<td>50.14 ± 3.69</td>
<td>49.97 ± 4.65</td>
</tr>
<tr>
<td>Monocytes</td>
<td>%</td>
<td>8.65 ± 0.54</td>
<td>2.02 ± 0.34</td>
<td>2.08 ± 0.45</td>
<td>2.08 ± 0.34</td>
<td>2.08 ± 0.34</td>
</tr>
<tr>
<td>Eosinophils</td>
<td>%</td>
<td>0.92 ± 0.07</td>
<td>0.72 ± 0.18</td>
<td>0.86 ± 0.38</td>
<td>0.78 ± 0.29</td>
<td>0.86 ± 0.15</td>
</tr>
<tr>
<td>Basophils</td>
<td>%</td>
<td>0.00 ± 0.00</td>
<td>0.00 ± 0.00</td>
<td>0.00 ± 0.00</td>
<td>0.00 ± 0.00</td>
<td>0.00 ± 0.00</td>
</tr>
</tbody>
</table>

* Values are significantly differing than control at P< 0.05.

### Table 10: Serum protein electrophoresis (g/dl) in ectoparasite-infested camels.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Healthy control camels</th>
<th>Tick-infested camels</th>
<th>C. bovis-infested camels</th>
<th>Before treatment</th>
<th>After treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total protein</td>
<td>7.13 ± 0.28</td>
<td>6.77 ± 0.22</td>
<td>6.81 ± 0.16</td>
<td>7.63 ± 0.59</td>
<td>7.90 ± 0.48</td>
</tr>
<tr>
<td>Albumin</td>
<td>3.52 ± 0.20</td>
<td>3.21 ± 0.23</td>
<td>3.51 ± 0.20</td>
<td>3.57 ± 0.56</td>
<td>3.79 ± 0.52</td>
</tr>
<tr>
<td>Total globulin</td>
<td>1.01 ± 0.200</td>
<td>0.98 ± 0.217</td>
<td>1.02 ± 0.200</td>
<td>1.06 ± 0.210</td>
<td>1.07 ± 0.230</td>
</tr>
<tr>
<td>L-globulin</td>
<td>1.11 ± 0.11</td>
<td>1.09 ± 0.07</td>
<td>1.14 ± 0.30</td>
<td>1.14 ± 0.30</td>
<td>1.20 ± 0.15</td>
</tr>
<tr>
<td>A-globulin</td>
<td>1.99 ± 0.17</td>
<td>1.52 ± 0.135</td>
<td>1.61 ± 0.200</td>
<td>1.78 ± 0.230</td>
<td>2.00 ± 0.230</td>
</tr>
<tr>
<td>MCH</td>
<td>0.97 ± 0.156</td>
<td>0.96 ± 0.09</td>
<td>0.96 ± 0.09</td>
<td>0.96 ± 0.055</td>
<td>0.97 ± 0.045</td>
</tr>
</tbody>
</table>

* Values are significantly differing than control at P< 0.05.
DISCUSSION

It has been generally recognized that camels are exposed to wide range of external parasites which irritate, debilitate and resulted in serious tissue damage both directly and indirectly. Consequently, the clinical signs observed in ectoparasite infested camels in the current study including mite, ticks and nasal boffy larvae confirm these facts and agree with those previously recorded by Hussain, et al. (1982), Higgins (1986), Pegram and Higgins (1992), Egbere-Nwiyi and Chaudhury (1996), Sushilra Sena et al. (1999a,b), Al-Rawashidah, et al. (2000), Bekere (2001), Zeleke and Bekele (2001) and Baraka and Fick (2003).

The prevalence of camel ectoparasites in this study was considerably coinciding with the findings of Sushilra Sena et al. (1999a,b) in India, Zeleke. and Bekele (2001) in Ethiopia, Rahman et al. (2002) in Pakistan and Jemli (2002) in Tunisia. However, our results were higher than those reported by Hamoda (2002) in the Nile Valley of Egypt and by Abo-El-Elia (2003) in the western Egyptian desert. This may be perhaps due to variations in the climatic conditions including warm weather and suitable humidity which may favor the flushing of these ectoparasites (Soulsby, 1982 and Higgins, 1986). On the other hand, the prevalence of ectoparasites noticed in slaughtered animals was higher than the field study (87.7% vs. 45.59% respectively) which was clearly due to detection of high number of camels infested by C. felitisor in the nasopharynx after postmortem examination.

In the current study, only one species of mite was recorded (Sarcoptes scabiei var camell). This result coincided with the reports of Pegram and Higgins (1992), Kumar et al. (1992) and Muhammad et al. (2001). The identification of ticks revealed species like Hymenoma dromedarii, Amblyomma lepidum and Ornithodora savignyi (sand lampau). H. dromedarii was the most abundant while A. lepidum and O. savignyi were found in less numbers. These results agree with Higgins (1986), El-Refaei and Wahba (2003) who mentioned that the variety of tick infestation in camels depend on the study area and geoclimatic conditions. Pegram and Higgins (1992) added that Hymenoma species is a highly desert adapted and widely distributed in arid areas. It was noticed that H. dromedarii was more condensed around and within the nostrils and ear than other parts of the body while other species were scattered on other soft parts of the body which agree with the reports of Higgins (1986).

The effect of season was clear on ectoparasitic infestation of camels. The highest rate of mite was recorded in winter while the
lowest was in summer. Similar results were obtained by Egie–Nwiyi and Chaudhri (1996), Suchitra Serna et al. (1999a) and El-Khalany and Abd allah (2001). The functioning skin and the high ambient temperature during summer may not favour the activity of flies which may hide in skin folds to protect themselves from sunlight (Grkoyan, 1987 and Abdel Rahim et al., 1995). Contrary to flies, the current study showed more pronounced prevalence of ticks during summer while it was at its lowest prevalence during winter. Those results coincide with those reported previously by Abdel Rahim et al. (1995) and El-Khalany and Abd allah (2001) which indicate that hot summer environment is the favourable condition for high prevalence of ticks. However, contrary reports found more activity of ticks during winter months (Robson et al., 1998 and Berdyev, 1969). The prevalence of C. indicus during the current study was more pronounced during winter and temperate seasons (spring and autumn). It seems that wet and temperate environment favour the multiplication of the flies with production of high number of larvae (Higgins, 1986 and Bekele, 2001).

The current study emphasized that age had a large effect on ectoparasitic infestation of camels. Older animals were more infested than young individuals. Those results agree with the findings of Higgins (1986), Pogeram and Higgins (1992), Egie–Nwiyi and Chaudhri (1996), Suchitra Serna et al. (1999a, b), Al-Rwaished, et al. (2000), Bekele (2001), Zeleke and Bekele (2001) and El-Khalany and Abd allah (2001). The higher rate of ectoparasitic infestation in aged camels might be perhaps due to the long time exposure of those animals to these ectoparasites. The quietness of older animals than the active and transmissible young individuals may also play role in the condensation of ectoparasites.

The current work showed that mange mites and bot flies were more prevalent with higher intensity in females than male camels, meanwhile tick infestation was more prevalent in males but females had higher burden of ticks. Those results are in agreement with the reports of Higgins (1980), Pogeram and Higgins (1992), Egie–Nwiyi and Chaudhri (1996), Suchitra Serna et al. (1999a), Al-Rwaished, et al. (2000), Bekele (2001) and Zeleke and Bekele (2001). The differences in the prevalence and burden in relation to sex might be due to the differences in the management, stress of pregnancy and lactation in addition to hormonal factors (Abd El-Gawad, 1979).

Haematological findings revealed normocyte normochromic anaemia in tick and nasal bot infested camels. Loss of blood encountered
by these parasites for feeding may be responsible for this type of anaemia. These results agree with those reported by Motamed et al. (1987). Higgins (1986) reported that blood loss might amount up to 3 ml for each tick completing its life cycle on the animal. In mange-infested camels, there was a microcytic hypochoelectric anaemia, which may indicate dissemnopoesis and disturbances in the reticulo-endothelial function (Jain, 1993 and Feldman et al., 2000).

Urquhart et al. (1986) and Warnery, et al. (1999) had described that Leukocytosis accompanied by lymphocytosis and eosinophilia are common features of parasitic diseases. In the present study, these changes were evident in all infested groups as a reaction of the host against the heavily invading parasite (Jain, 1993 and Feldman, et al., 2000).

The current work revealed that blood serum proteins were highly affected by the ectoparasitic infestation in camels. The mean values of blood serum albumin were significantly decreased in infested camels. Similar results were obtained in camel sarcoposis by Rahman et al. (2002) but there were no available literatures to compare such reduction in tick and nasal bot infestation. The reduction of blood serum albumin in this study may reflect the anemia and disturbed nutritional status of these camels as a result of irritation and discomfort. The loss of exudates due to tissue injuries may also be a contributing factor for reduction of blood serum albumin.

The mean values of blood serum alpha globulin were significantly increased in parasitized camel than controls. By tracing the available literatures, there were no reports describe the behaviour of alpha band of protein electrophoresis during external parasitic infestation. However, according to Jain (1993), Kando (1997) and Thomas (2000a,b) this rise in alpha globulin indicate induction of pivotal pro-inflammatory cytokines and production of acute phase proteins (APP). Those APP are the main components of alpha globulin region as haptoglobin, α1-antitrypsin and serum amyloid A (Thomas, 2000a,b), which up till now they had not been recognized in camels yet. The acute cases, severe intensity of infestation and perhaps invasion of secondary bacterial infection to the injured tissues in the examined camels in this work may suggest the induction of those cytokines. Consequently these cytokines synthesized the liver for production of acute inflammatory reactons and hence the α-globulin region increased. Liver involvement in ectoparasitic infestation was noticed by Fister and Crookshank (1982), and production of
inflammatory cells which attracted to the site of infestation by means of chemotacticants secreted by the parasite was postulated by Ulril (1991) and Zahran (1997).

The mean values of betaglobulin region in this work did not show significant variation in infested camels when compared with control animals meanwhile the mean values of gammaglobulin was increased. It seems that there are no similar reports to compare betaglobulin values but the elevated gammaglobulin were in consistent with the reports of Rehav et al. (1991) in laboratory animals, Banerjee et al. (1990), Sahibi et al. (1997) in cattle and Szabo et al. (2003) in dogs. It was noticed that the elevation of gammaglobulin was comparable with the induced lymphocytosis in this study. Skerritt (2003) noticed presence of plasma cells and B-lymphocytes in wombats experimentally infected with external parasites and suggested that some immune tolerance may develop with severe infections.

The sum of globulin fractions values resulted in hypoglobulinaemia, meanwhile the sum of albumin and globulin resulted in hypoproteinaemia in infested camels if compared with control animals. This consequently resulted in decreased A/G ratio in diseased groups. These result agree with those reported by El-Kholany and Abdallah (2001) and Rahiman et al. (2002).

Treatment of mange infested cases with Ivermectin resulted in the disappearance of the clinical signs and restore of the investigated haematological and biochemical parameters. These results agree with those reported by Happe (1988) and Lopppard and Nahuri (2000) who reported that the discovery of Ivermectin, a derivate of Streptomyces avermethyl which is now already fully integrated as an effective antiparasitic drug.

This paper had created a practical emphasis on the ecology and biocumatics of ectoparasitic fauna harbouring pastoral camel reared at the eastern south part of the eastern desert of Egypt. Further investigation into the relationship between parasite burden and health of camels is required to assess the emphasized potential significance of pastoral camel ectoparasitism.

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