

Bacteria of Wild *Hyalomma Dromedarii* (Ixodidae) and *Argas Persicus* (Argasidae) and their Antibiotic Sensitivities

بكتيريا من هياالوما دروميداري (إكسوديدي) وأرجس برسيسكس (أرجاسيدي) بريين وحساسيتهم للمضادات الحيوية

Ashraf Ahmed Montasser

Department of Biology, Faculty of Science, United Arab Emirates University,
PO box: 17551, Al-Ain, United Arab Emirates, e-mail: a.montasser@uaeu.ac.ae
Permanent Address:

Department of Zoology, Faculty of Science, Ain Shams University, Cairo, Egypt.

Abstract: Four bacterial species, namely *Serratia liquefaciens*, *Stenotrophomonas maltophilia*, *Klebsiella ornithinolytica* and *Aeromonas hydrophila* were isolated from *Hyalomma (hyalomma) dromedarii*, and five species, namely: *Rahnella aquatilis*, *Pseudomonas fluorescens*, *Enterobacter cloacae*, *Chryseomonas luteola* and *Chryseobacterium meningosepticum* from *Argas (Persicargas) persicus* organs and haemolymph. Isolated bacteria were identified using the Analytical Profile Index 20E. The disk diffusion test was carried out on isolated bacteria to determine their antibiotic sensitivity. All bacteria from *H. dromedarii* were found to be sensitive to chloramphenicol, amoxicillin/clavulanic acid, neomycin, streptomycin, tetracycline and nitrofurantion, whilst bacteria isolated from *A. persicus*, were found to be completely sensitive to tetracycline and mostly sensitive to chloramphenicol and triplesulphur. Appropriate antibiotics should be concurrently administered to hosts during tick control procedures.

Keywords: Antibiotics, *argas*, gram-negative bacteria, *hyalomma*, ixodoidea.

المستخلص: تم عزل أربعة أنواع من البكتيريا تسمى سيراشيا ليكويفاكينس، ستينوتروفوموناس مالتوفيليا، كليبيسيلا أورنيثينوليتيكا وأيروموناس هيدروفيليا، من أعضاء وهيموليمف القراد هياالوما (هياالوما) دروميداري وخمسة أنواع تسمى راهنيلا أكواتيليس وسيدوموناس فلوريسنس وإنتيروباكترا كلاوي وكريسيوموناس ليتولا وكريسيوباكتيريوم مينينجوسيبتيكوم من أعضاء وهيموليمف القراد أرجس (برسيكارجس) برسيسكس. تم تعريف البكتيريا المنعزلة، باستخدام اختبار صفحة القائمة التحليلية رقم E20. تم تطبيق اختبار قرص الانتشار على البكتيريا المنعزلة، لتحديد حساسيتهم للمضادات الحيوية. وجدت حساسية للكولورامفينيكول والأموكسيلين/حمض الكلافولانيلك والنيوميسين والإستربتوميسين والتتراسيكلين والنيتروفورانشن، بالنسبة لأنواع البكتيريا المنعزلة من القراد هياالوما دروميداري، في حين أن الأنواع المنعزلة من القراد أرجس برسيسكس، وجدت كلها حساسة للتتراسيكلين ومعظمها حساسة للكولورامفينيكول والكبيريت الثلاثي. من هذه الدراسة يمكننا إنتقاء المضادات الحيوية المناسبة الواجب إعطائها للعائل أثناء عملية مقاومة القراد. كلمات مدخلية: مضادات حيوية، أرجس، بكتيريا منعزلة، القراد، إكسوديدي.

Introduction

Hyalomma (H.) domedarii, the camel tick, participates in the epidemiology of Quaranfil virus (Converse and Moussa, 1982), Q fever (*Coxiella burnetii*) (Bazlikova, et al. 1984) and Crimean-Congo hemorrhagic fever virus (Rodriguez, et al. 1997). *Argas (P.) persicus*, the fowl tick, is an efficient reservoir and/or vector for *Borrelia anserina* and *Aegyptianella pullorum*, which are serious pests for domestic birds (Gothe, et al. 1981) as well as many viruses (Hoogstraal, 1985; Nemova, et al. 1990).

Electron microscopic studies revealed the inclusion of bacteria in the oocytes of *A. persicus* and these bacteria were identified as rickettsia-like microorganisms (Montasser, 2000). Through similar studies, this imprecise identification, or the term endocytobionts, was previously applied to microorganisms in the ovary of *Ixodes ricinus*

(Lewis, 1979), synganglion of *Ornithodoros erraticus* (El Shoura, 1986), ovary and Malpighian tubules of *O. moubata* (Amiessami, 1988), salivary glands, ovary, mid-gut, Malpighian tubules and haemocytes of laboratory-reared *A. arboreus* (El Shoura, 1990), ovary of *Dermacentor reticulatus* (Šutákovéá and Řeháček, 1991) and sperm cells of three ixodid ticks (El Said, 1992). Through immunofluorescent antibody methods, the same identification was reported in hemolymph of ixodid ticks (Magnarelli, et al. 1995; DeLemos, et al. 1997). Thus, there is a need to study these bacteria by other means, such as biochemical characteristics, in an attempt to present more accurate definition.

The Analytical Profile Index 20E (API 20E) is a biochemical test kit used for the identification of gram-negative bacteria in three species of carrion beetles (Solter, et al. 1989), three species of mosquitoes (Demaio, et al. 1996) and *Hirudo medicinalis* (Eroglu, et al. 2001). This technique has

rarely been used with ticks. The aim of the present investigation was to identify bacterial species in different organs of two medically and economically important tick species as a contribution towards understanding their interaction with the host body and to describe the antibacterial susceptibility that can be applied to reduce the risk created by tick feeding.

Materials and Methods

H. dromedarii were collected from camels in Al-Ouha farm, Al-Ain city, United Arab Emirates during October 2001. *A. persicus* were collected from chicken houses in Giza Governorate, Egypt during July 2002. Prior to dissection, ticks were externally sterilized in 70% ethanol for 10 min followed by rinsing in sterile saline. Ten specimens of each species were dissected in 0.7% NaCl solution. Organ dissection was performed under sterile conditions. Organs and haemolymph were separately streaked on tryptic soy agar plates and incubated at 37°C for 24 hours. Different morphologically characteristic bacterial colonies were separately subcultured to fresh agar plates. Gram staining was performed for all cultured bacteria. The Analytical Profile Index (BioMerieux S.A., France) (API 20E-09264B-07/99) was used for bacterial identification (Harley and Prescott, 1999). The individual test consists of 20 dehydrated chemicals in a set of plastic cupules that are inoculated with a bacterial suspension. Reaction of cytochrome-oxidase was also tested. The disk diffusion test was carried out to determine antibiotic sensitivity as described by Harley and Prescott

(1999). The test includes the use of standardized paper disks of known absorptive capacity containing known amounts of antimicrobial agents to measure the in vitro susceptibility of microorganisms to these agents. Antibiotics tested included chloramphenicol, amoxicillin/clavulanic acid, neomycin, streptomycin, triplesulpher, tetracycline and nitrofurantion.

Results

A total of nine species of bacteria were identified from organs and haemolymph of both tick species (Table 1). Four species, namely *Serratia liquefaciens*, *Stenotrophomonas maltophilia*, *Klebsiella ornithinolytica* and *Aeromonas hydrophila*, were isolated from *H. dromedarii* and five species, namely *Rahnella aquatilis*, *Pseudomonas fluorescens*, *Enterobacter cloacae*, *Chryseomonas luteola* and *Chryseobacterium meningosepticum*, were isolated from *A. persicus* (Table 1). *S. liquefaciens* and *C. luteola* were isolated from most organs of *H. dromedarii* and *A. persicus*, respectively.

Bacterial isolates from *H. dromedarii* were found to be sensitive to chloramphenicol, amoxicillin/clavulanic acid, neomycin, streptomycin, tetracycline and nitrofurantion (Table 2). Negative susceptibility was recorded in *St. maltophilia* to triplesulpher.

In *A. persicus*, all isolates were sensitive to tetracycline and variably sensitive to other antibiotics (Table 3). They were also found to be sensitive to chloramphenicol and triplesulpher, except for *E. cloacae* and *Ch. meningosepticum*, which showed negative sensitivity.

Table 1: Bacterial species in different organs and haemolymph of *Hyalomma (H.) dromedarii* and *Argas (P.) persicus*

	<i>Hyalomma (H.) dromedarii</i>	<i>Argas (P.) persicus</i>
Gut	<i>Stenotrophomonas maltophilia</i> <i>Serratia liquefaciens</i>	<i>Rahnella aquatilis</i>
Salivary glands	<i>Klebsiella ornithinolytica</i> <i>Serratia liquefaciens</i>	<i>Pseudomonas fluorescens</i> <i>Chryseomonas luteola</i>
Ovary	<i>Aeromonas hydrophila</i>	<i>Enterobacter cloacae</i> <i>Chryseomonas luteola</i>
Testis	<i>Serratia liquefaciens</i>	<i>Chryseomonas luteola</i>
Brain	<i>Serratia liquefaciens</i>	<i>Chryseomonas luteola</i>
Haemolymph	<i>Serratia liquefaciens</i>	<i>Chryseobacterium meningosepticum</i> <i>Chryseomonas luteola</i>

Table 2: Sensitivity of different bacteria isolated from *Hyalomma (H.) dromedarii* to different antibiotics.

	<i>Serratia liquefaciens</i>	<i>Stenotrophomonas maltophilia</i>	<i>Klebsiella ornithinolytica</i>	<i>Aeromonas hydrophila</i>
Chloramphenicol 30 µg	S	S	S	S
Amoxillin/Clavulanic acid 30 µg	I	S	I	S
Neomycin 30 µg	S	S	I	S
Streptomycin 10 µg	S	S	I	S
Triplexsulpher 0.25 µg	S	R	I	I
Tetracycline 30 µg	S	I	S	S
Nitrofurantion 300 µg	S	S	S	S

S= Susceptible, I= Intermediate susceptibility, R= Resistant.

Table 3: Sensitivity of different bacteria isolated from *Argas (P.) persicus* to different antibiotics.

	<i>Enterobacter cloacae</i>	<i>Rahnella aquatilis</i>	<i>Pseudomonas fluorescens</i>	<i>Chryseobacterium meningosepticum</i>	<i>Chryseomonas luteola</i>
Chloramphenicol 30 µg	R	S	S	S	I
Amoxillin/Clavulanic Acid 30 µg	R	S	S	S	R
Neomycin 30 µg	R	I	I	I	R
Streptomycin 10 µg	R	S	S	S	R
Triplexsulpher 0.25 µg	S	S	I	R	S
Tetracycline 30 µg	I	S	S	I	S
Nitrofurantion 300 µg	I	R	S	R	R

S= Susceptible, I= Intermediate susceptibility, R= Resistant.

Discussion

More bacterial species were isolated from the gut and salivary glands of *H. dromedarii* and *A. persicus*. This finding suggests that these organs are an important bacterial source as they are in nearby contact with wound sites. Similarly, the largest number of rickettsia-like microorganisms was previously noticed in the cells of these organs of *A. arboreus* (El Shoura, 1990). Bacterial isolations from salivary glands, haemolymph or brain may be from previous stages, i.e. from larvae to nymphs to adults which has been called trans-stadial transmission while those isolated from the ovary or testis will be transmitted to the eggs, supporting the case of trans-ovarial transmission (Hoogstraal, 1985). This corresponds to the study of Amiressami (1988), who observed endocytobionts in the blastoderm and yolk cells during the early embryonic development of *Ornithodoros moubata*.

According to Bergey's Manual of Systematic Bacteriology, the genera *Klebsiella*, *Enterobacter*,

Rahnella and *Serratia* belong to the family Enterobacteriaceae and the genus *Aeromonas* related to the family Vibrionaceae (Krieg, 1984). Both families are gram-negative facultatively anaerobic rods. The genera *Stenotrophomonas*, *Pseudomonas*, *Chryseomonas* and *Chryseobacterium* belong to the gram-negative aerobic rod and coccus family *Pseudomonadaceae* (Krieg, 1984). Gram-negative bacteria include more prevalent and dangerous species of bacteria such as the causative agent of plague, *Yersinia pestis*, which was isolated from the soft tick *Ornithodoros tartakovskyi* (Bilyalov, et al. 1983).

In the present study, *S. liquefaciens* was obtained in most organs of *H. dromedarii*. It is the most prevalent *Serratia* species in the natural environment (plants and digestive tract of rodents) (Krieg, 1984). It is an unusual human pathogen, as it has recently been recognized as a potential cause of transfusion-related sepsis and is associated with a high mortality rate (Roth, et al. 2000). *St. maltophilia* from gut of the above tick was previously isolated from the gut

of the blood sucking flies *Lutzomyia longipalpis* (Oliveira, *et al.* 2000) and *Pollenia rudis* (Faulde, *et al.* 2001). *St. maltophilia*, an important nosocomial pathogen, was reported to be the main cause of a melioidosis-like abscess in the human liver (Petri, *et al.* 2003). Its susceptibility to ticarcillin-clavulanic acid (Ubeda, *et al.* 1998) and chloramphenicol (Friedman, *et al.* 2002) is consistent with the present study.

Bacteria of the genus *Klebsiella* are important opportunistic pathogens responsible for nosocomial infections that are increasingly resistant to antimicrobial agents (Stock and Wiedemann, 2001). Studies on *K. ornithinolytica*, isolated from salivary glands of *H. dromedarii*, have mainly been confined to the level of identification and antibiotic susceptibility. Its sensitivity to tetracycline, chloramphenicol and nitrofurantion greatly resemble that described by Stock and Wiedemann (2001). *Aer. hydrophila*, isolated from the ovary of *H. dromedarii*, was found to be pathogenic to frogs, fish and mammals, including man (Krieg, 1984). It was isolated from the gut of the blood sucking fly *Chrysomya megacephala* (Sukontason, *et al.* 2000) and the leech *H. medicinalis* (Eroglu, *et al.* 2001).

R. aquatilis, isolated from gut of *A. persicus* in the present study, occurs in freshwater and may occasionally be isolated from human clinical specimens (Krieg, 1984). It was isolated from the blood cultures of adult patients and showed to be highly sensitive to amoxicillin-calvulanic acid (Caroff, *et al.* 1998) similar to the present study. *P. fluorescens*, from the salivary glands of the above tick, has often been isolated from clinical specimens (Krieg, 1984). This bacterial species was used for the production of a mosquitocidal exotoxin (Murty, *et al.* 1994) and recently for the biocontrol of *Culex quinquefasciatus* (Sadanandane, *et al.* 2003).

E. cloacae, isolated from the ovary of *A. persicus*, was isolated from cloaca of the duck *Dendrocygna autumnalis* (Aguirre, *et al.* 1992), blood cultures of the macaw *Ara ararauna* (Isaza, *et al.* 1992) and poultry skin (Hinton and Ingram, 2000). Sensitivity of the *E. cloacae* strain of the present study to antibiotics is greatly consistent with that previously described (Krieg, 1984; Hofacre, *et al.* 2001).

C. luteola, isolated from most organs of *A. persicus* in the present study, was reported from blood of neurosurgical (Kostman, *et al.* 1991), facial cellulitis and pancreatic abscess patients (Rastogi and Sperber, 1998). *Ch. meningosepticum*, isolated from the hemolymph of this tick, was previously

isolated from the leech *H. medicinalis* (Eroglu, *et al.* 2001) and blood cultures of four newborns (Tekerekoglu, *et al.* 2003). However, the latter authors noticed resistance to tetracycline, the present strain is sensitive to it.

Although most of the above bacteria are harmful to man or domestic animals and have been isolated from blood sucking insects and noted for their particular association with tick organs, their role as symbiotes, commensals or parasites in the tick body is still not clear, as mentioned by El Shoura (1990). Balashov (1972) reported that rickettsia-like microorganisms might provide the tick requirements for vitamins of the B-complex and metabolites lacking or deficient in vertebrate blood.

Isolating and identifying bacterial species from ticks may be useful for the biological control studies of ticks themselves as mentioned by Burgdorfer, *et al.* (1973) who isolated rickettsia-like microorganisms from *Dermacentor andersoni*, inoculating some of them into the haemocoel of female *D. andersoni* and noticed their multiplication within organs that resulted in the death of the tick. Recently, the present tick species were greatly affected by three varieties of the bacteria *Bacillus thuringiensis* (Hassanain, *et al.* 1997). Identifying bacterial species as well as their antibiotic susceptibility will add knowledge to their biological properties that are a practical requirement for their application in the biological control process.

Acknowledgment

I am greatly grateful to Dr. Mohamed R Enan, Agricultural Genetic Engineering Research Institute, ARC, Giza, Egypt, for his assistance with the bacterial identifications, outstanding technical support and for helpful review of the manuscript.

References

- Aguirre, AA, Quan, TJ, Cook, RS, and McLean, RG (1992) Cloacal flora isolated from wild black-bellied whistling ducks (*Dendrocygna autumnalis*) in Laguna La Nacha, Mexico. *Avian Dis.* **36**: 459-62.
- Amiressami, M (1988) Interaction of endocytobionts in ticks (Ixodoidea: Argasidae): New aspects in ultrastructural and physiological relations of endocytobionts to their hosts. *Endocytob. Cell Res.* **5**: 309-325.
- Balashov, Yu S (1972) Bloodsucking ticks (Ixodoidea)-Vectors of diseases of man and animals. Nauka, Leningrad. English Translation, Misc. Publ. Ent. Soc. Am. **8**: 161-376.

- Bazlikova, M, Kazar, J, and Schramek, S** (1984) Phagocytosis of *Coxiella burnetii* by *Hyalomma dromedarii* tick haemocytes. *Acta Virol.* **28**: 48-52.
- Bilyalov, ZA, et al.** (1983) Effect of long survival in the *Ornithodoros tartakovskyi* (Argasidae) tick body on plague agent properties. *Parazitologiya* **17**: 75-76.
- Burgdorfer, W, Brinton, LP, and Hughes, LE** (1973) Isolation and characterization of symbiotes from the Rocky Mountain wood tick *Dermacentor andersoni*. *J. Invert. Pathol.* **22**: 424-434.
- Caroff, N, et al.** (1998) Two epidemiologically related cases of *Rahnella aquatilis* bacteremia. *Eur. J. Clin. Microbiol. Infect. Dis.* **17**: 349-52.
- Converse, JD and Moussa, MI** (1982) Quaranfil virus from *Hyalomma dromedarii* (Acari: Ixodoidea) collected in Kuwait, Iraq and Yemen. *J. Med. Entomol.* **19**: 209-10.
- DeLemos, ER, et al.** (1997) Rickettsiae-infected ticks in an endemic area of spotted fever in the State of Minas Gerais, Brazil. *Mem. Inst. Oswaldo Cruz.* **92**: 477-81.
- Demaio, J, Pumpuni, CB, Kent, M, and Beier, JC** (1996) The midgut bacterial flora of wild *Aedes triseriatus*, *Culex pipiens*, and *Psorophora columbae* mosquitoes. *Am. J. Trop. Med. Hyg.* **54**: 219-223.
- El Said, A** (1992) Ultrastructure of symbiont-like microorganisms associated with the sperm of ixodid ticks. *J. Egypt. Soc. Parasitol.* **22**: 293-7.
- El Shoura, SM** (1986) Fine structure of the synganglion of *Ornithodoros (Pavlovskyella) erraticus* (Ixodoidea: Argasidae). *Acarologia* **27**: 295-302.
- El Shoura, SM** (1990) Ultrastructure and distribution of intracellular rickettsia-like microorganisms in various organs of the laboratory-reared adult tick *Argas (Persicargas) arboreus* (Ixodoidea: Argasidae). *Exp. Appl. Acarol.* **9**: 137-143.
- Eroglu, C, et al.** (2001) Bacterial flora of *Hirudo medicinalis* and their antibiotic sensitivities in the Middle Black Sea region, Turkey. *Ann. Plast. Surg.* **47**: 70-3.
- Faulde, M, Sobe, D, Burghardt, H, and Wermter, R** (2001) Hospital infestation by the cluster fly, *Pollenia rudis sensu stricto* Fabricius 1794 (Diptera: Calliphoridae), and its possible role in transmission of bacterial pathogens in Germany. *Int. J. Hyg. Environ. Health* **203**: 201-4.
- Friedman, ND, et al.** (2002) Bacteraemia due to *Stentrophomonas maltophilia*: an analysis of 45 episodes. *J. Infect.* **45**: 47-53.
- Gothe, R, Buchheim, C, and Schrecke, W** (1981) *Argas (Persicargas) persicus* and *Argas (Argas) africanus* as natural vectors of *Borrelia anserina* and *Aegyptianella pullorum* in Upper Volta. *Berl. Munch. Tierarztl. Wochenschr.* **94**: 280-285 (In German).
- Harley, JP and Prescott, LM** (1999) Laboratory exercises in microbiology. 4th ed. McGraw-Hill Co. Inc., USA.
- Hassanain, MA, et al.** (1997) Biological control studies of soft and hard ticks in Egypt. I. The effect of *Bacillus thuringiensis* varieties on soft and hard ticks (Ixodidae). *Parasitol. Res.* **83**: 209-13.
- Hinton, A Jr and Ingram, KD** (2000) Use of oleic acid to reduce the population of the bacterial flora of poultry skin. *J. Food Prot.* **63**: 1282-6.
- Hofacre, CL, et al.** (2001) Characterization of antibiotic-resistant bacteria in rendered animal products. *Avian Dis.* **45**: 953-61.
- Hoogstraal, H** (1985) Argasid and nuttalliellid ticks as parasites and vectors. *Adv. Parasitol.* **24**: 135-238.
- Isaza, R, Buergelt, C, and Kollias, GV** (1992) Bacteremia and vegetative endocarditis associated with a heart murmur in a blue-and-gold macaw. *Avian Dis.* **36**: 1112-6.
- Kostman, JR, Solomon, F, and Fekete, T** (1991) Infections with *Chryseomonas luteola* (CDC group Ve-1) and *Flavimonas oryzihabitans* (CDC group Ve-2) in neurosurgical patients. *Rev. Infect. Dis.* **13**: 233-6.
- Krieg, NR** (1984) *Bergey's Manual of Systematic Bacteriology*. Williams and Wilkins Press, Baltimore, USA.
- Lewis, D** (1979) The detection of rickettsia-like microorganisms within the ovaries of female *Ixodes ricinus* ticks. *Z. Parasitenkd.* **59**: 295-8.
- Magnarelli, LA, et al.** (1995) Hemocytic rickettsia-like organisms in ticks: serologic reactivity with antisera to Ehrlichiae and detection of DNA of agent of human granulocytic ehrlichiosis by PCR. *J. Clin. Microbiol.* **33**: 2710-4.
- Montasser, AA** (2000) The effect of ivermectin on the tick, *Argas (Persicargas) persicus* (Oken, 1818) (Ixodoidea: Argasidae). Ph.D. thesis. Ain Shams University, Cairo, Egypt.
- Murty, MG, Srinivas, G, and Sekar, V** (1994) Production of a mosquitocidal exotoxin by a *Pseudomonas fluorescens* strain. *J. Invertebr. Pathol.* **64**: 68-70.
- Nemova, NV, et al.** (1990) Experimental study of the replication of Hissar virus (Bunyaviridae) in the tick *Argas persicus* (Oken, 1818). *Meditsinskaya Parazitologiya I Parazitarnye Bolezni* **1**: 35-36.
- Oliveira, SM, et al.** (2000) Prevalence of microbiota in the digestive tract of wild females of *Lutzomyia longipalpis* Lutz & Neiva, 1912 (Diptera: Psychodidae). *Rev. Soc. Bras. Med. Trop.* **33**: 319-22.
- Petri, A, et al.** (2003) Liver abscess caused by *Stentrophomonas maltophilia*: report of a case. *Surg. Today* **33**: 224-8.

- Rastogi, S and Sperber, SJ** (1998) Facial cellulites and *Pseudomonas luteola* bacteremia in an otherwise healthy patient. *Diagn. Microbiol. Infect. Dis.* **32**: 303-5.
- Rodriguez, LL, et al.** (1997) Molecular investigation of a multisource outbreak of Crimean-Congo hemorrhagic fever in the United Arab Emirates. *Am. J. Trop. Med. Hyg.* **57**: 512-8.
- Roth, VR, et al.** (2000) Transfusion-related sepsis due to *Serratia liquefaciens* in the United States. *Transfusion* **40**: 931-5.
- Sadanandane, C, Reddy, CM, Prabakaran, G, and Balaraman, K** (2003) Field evaluation of a formulation of *Pseudomonas fluorescens* against *Culex quinquefasciatus* larvae and pupae. *Acta Trop.* **87**: 341-3.
- Solter, LF, Lustigman, B, and Shubeck, P** (1989) Survey of medically important true bacteria found associated with carrion beetles (Coleoptera: Silphidae). *J. Med. Entomol.* **26**: 354-9.
- Stock, I and Wiedemann, B** (2001) Natural antibiotic susceptibility of *Klebsiella pneumoniae*, *K. oxytoca*, *K. planticola*, *K. ornithinolytica* and *K. terrigena* strains. *J. Med. Microbiol.* **50**: 396-406.
- Sukontason, et al.** (2000) Mechanical carrier of bacterial enteric pathogens by *Chrysomya megacephala* (Diptera: Calliphoridae) in Chiang Mai, Thailand. *Southeast Asian J. Trop. Med. Public Health* **31**(1): 157-61.
- Šutáková, G and Řeháček, J** (1991) Endocytobionts in Dermacentor reticulatus ticks (Ixodidae): An electron microscope study. *Exp. Appl. Acarol.* **11**: 57-72.
- Tekerekoglu, et al.** (2003) Analysis of an outbreak due to *Chryseobacterium meningosepticum* in a neonatal intensive care unit. *New Microbiol.* **26**: 57-63.
- Ubeda, et al.** (1998) Bacteremia caused by *Stenotrophomonas maltophilia*: a clinical-epidemiological study and resistance profile. *Rev. Esp. Quimioter* **11**: 205-15.

Received, 22nd Dec. 2003; in revised form; 10th May 2004