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Supplement 2003-2007 (no. 47) to the White-Kauffmann-Le Minor scheme

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1 **Abstract**

2 This supplement reports the characterization of 70 new *Salmonella* serovars recognized
3 between 2003 and 2007 by the WHO Collaborating Centre for Reference and Research on
4 *Salmonella*: 44 were assigned to *Salmonella enterica* subspecies *enterica*, 11 to subspecies
5 *salamae*, 5 to subspecies *arizonae*, 8 to subspecies *diarizonae*, one to subspecies *houtenae*
6 and one to *S. bongori*. One new serovar, Mygdal, displayed a new H factor, H:z₉₁.

7

8 *Key words: Salmonella; Serovars; Taxonomy; White-Kauffmann-Le Minor scheme*

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1 **1. Introduction**

2 The genus *Salmonella* consists of only two species, *Salmonella enterica* and *S.*
3 *bongori*. *S. enterica* is divided into six subspecies: *S. enterica* subsp. *enterica*, *S. enterica*
4 subsp. *salamae*, *S. enterica* subsp. *arizonae*, *S. enterica* subsp. *diarizonae*, *S. enterica* subsp.
5 *houtenae*, and *S. enterica* subsp. *indica*; and. This nomenclature reflects present
6 understanding of *Salmonella* taxonomy [1, 4]. Serovars belonging to *S. enterica* subsp.
7 *enterica* are typically designated by a name usually related to the geographical place where the
8 serovar was first isolated. The serovar name is written in non-italicized Roman letters and the
9 first letter capitalized. Serovars belonging to other subspecies are designated by their antigenic
10 formulae, following the subspecies name. The antigenic formulae of *Salmonella* serovars are
11 listed in a document called the White-Kauffmann-Le Minor scheme [3]. Updating this scheme
12 is the responsibility of the WHO Collaborating Centre for Reference and Research on
13 *Salmonella* (WHO-Salm), Institut Pasteur, Paris, France. The current edition (9th) issued in
14 2007 comprises antigenic formulae validated as of January 1st 2007.

15 Supplement 47 reports the characterization of 70 new *Salmonella* serovars recognized
16 between 2003 and 2007 by the WHO-Salm: 44 were assigned to *S. enterica* subsp. *enterica*,
17 11 to subspecies *salamae*, 5 to subsp. *arizonae*, 8 to subsp. *diarizonae*, one to subspecies
18 *houtenae*, and one to *S. bongori* (Table 1). Variants of previously described serovars are
19 provided in Table 2. The present number of serovars per species and subspecies is given in

1 Table 3.

2 The strain 1357K (strain 9744/07) (Table 1), originally described by Kauffmann as the
3 reference strain of *S. enterica* subsp. *enterica* serovar Hisingen (48:a:1,5,7), was recently
4 found to be *S. enterica* subsp. *salamae* serovar 48:z₈₁:1,5,7. Consequently the serovar
5 Hisingen will be withdrawn in the next issue of the White-Kauffmann-Le Minor scheme.

6 Additionally, a new H factor, H:z₉₁, was identified in one new serovar, *S. enterica* serovar
7 Mygdal (strain 9398/03) (Table 1). A partial sequence (1250 bp) of the *fliC* gene encoding
8 H:z₉₁ has been submitted to GenBank (accession number GQ280905). The *fliC* allele
9 encoding H:z₉₁ was related to alleles encoding H:b. Antiserum to H:z₉₁ was prepared
10 following WHO-Salm guidelines [2]. Briefly, rabbits were immunized using strain 9398/03.
11 The crude antiserum (diluted 1:5) was successively absorbed with a boiled culture of strain
12 9398/03 to remove O agglutinins. Absorbtion with formalin-treated cultures of serovar Wien
13 strain 320K (H:b) and serovar Ohio strain CDC 1115-874/64 (H:b) were then performed to
14 remove cross-reactions with the H:b antigen. This absorbed antiserum agglutinated only the
15 motile culture of strain 9398/03.

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2

3 We thank all the National Reference Centres that have sent the new serovars or variants to
4 the WHO-Salm:

5

6 **Austria :**

7 -Institut für Medizinische Mikrobiologie (IMED), Graz (C. Kornschober)

8 **Belgium :**

9 -Institut Scientifique de Santé Publique, Brussels (S. Bertrand and J.M.
10 Collard).

11 **Canada :**

12 -National Microbiology Laboratory (NML), Winnipeg (D. Woodward and H.
13 Tabor).

14 -Laboratory for Foodborne Zoonoses (LFZ), Guelph (A. Muckle).

15 **Denmark :**

16 -Statens Serum Institute (SSI), Copenhagen (J. Sonne-Hansen).

17 **Finland :**

18 -National Public Health Institute (NPHI), Helsinki (S. Lukinmaa and A.
19 Siitonen).

20 **France :**

21 -Institut Pasteur (IP), Paris (F.-X. Weill and P.A.D. Grimont).

22 **Germany :**

23 -Federal Institute for Risk Assessment (BfR), Berlin (A. Schroeter and C.
24 Dorn).

25 -Institut für Hygiene und Umwelt (IHU), Hamburg (J. Bockemühl and P.
26 Roggentin).

27 -Robert Koch Institute (RKI), Wernigerode (W. Rabsch).

28 **Ireland :**

- 1 -National University of Ireland (NUI), Galway (N. De Lappe and M.
2 Cormican).
- 3 **Israel :**
- 4 -Government Central Laboratories (GCL), Jerusalem (A. Reisfeld)
- 5 **New Zealand :**
- 6 -Institute of Environmental Science and Research Limited (ESR), Porirua (D.
7 Duncan).
- 8 **Norway :**
- 9 -Norwegian Institute of Public Health (NIPH), Oslo (J. Lassen)
- 10
- 11 **Senegal:**
- 12 -Institut Pasteur de Dakar (IPD), Dakar (J.-D. Perrier-Gros-Claude and B.
13 Garin).
- 14 **Sweden :**
- 15 -Swedish Institute for Infectious Disease Control (SIIDC), Solna (R. Wollin).
- 16 **Switzerland :**
- 17 -Institut de Bactériologie Vétérinaire (IBV), Bern (H. Hächler)
- 18 **Thailand :**
- 19 -National Institute of Health (TNIH), Nonthaburi (P. Sawanpanyalert).
- 20 **USA**
- 21 -Centers for Disease Control and Prevention (CDC), Atlanta (P.I. Fields)
- 22
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References

- 1
- 2 [1] Judicial Commission, The type species of the genus *salmonella* Lignieres 1900 is
- 3 *Salmonella enterica* (ex Kauffmann and Edwards 1952) Le Minor and Popoff 1987, with
- 4 the type strain LT2^T, and conservation of the epithet *enterica* in *Salmonella enterica*
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- 6 Microbiol. 55 (2005) 519-520.
- 7 [2] Popoff M.Y., Guidelines for the preparation of *Salmonella* antisera, 6th revision, WHO
- 8 Collaborating Centre for Reference and Research on *Salmonella*, Institut Pasteur, Paris,
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- 10 [3] Grimont P.A.D, Weill F.-X., Antigenic formulae of the *Salmonella* serovars, 9th edition,
- 11 WHO Collaborating Centre for Reference and Research on *Salmonella*, Institut Pasteur,
- 12 Paris, 2007. Available at :
- 13 http://www.pasteur.fr/sante/clre/cadreocr/salmoms/WKLM_En.pdf
- 14 [4] Tindall B.J., Grimont P.A.D., Garrity G.M., Euzéby J.P. Nomenclature and taxonomy of
- 15 the genus *Salmonella*, Int. J. Syst. Evol. Microbiol. 55 (2005) 521-524.
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1 **Table 1.** New *Salmonella* serovars recognized by the WHO Collaborating Centre for
 2 Reference and Research on *Salmonella*, 2003-2007.

3

Serovar name	Antigenic formula	Other characters ^c	Source	Area of contamination or isolation	Year	IP strain number	Received from ^d
<i>Salmonella enterica</i>							
subsp. <i>enterica</i>							
Korkeasaari	28:e,h:1,5		Lizard	Africa	2003	9370/03	NPHI
Moabit	16:e,h:l,w		Melon kernel Meal	Germany	2003	9374/03	BfR
Kaevlinge	16:z ₄ ,z ₂₄ :-		Environment	Sweden	2002	9375/03	SIIDC
Mygdal	4,12:z ₉₁ :-		Swine faeces	Denmark	2003	9398/03	SSI
Epalinges	43:l,w:-	01-	Environment	Switzerland	2003	9428/03	IBV
Farmingdale	43:z ₄ ,z ₂₃ :-		Lizard	USA	2003	9447/03	CDC
Amberg	6,14,24:l,v:1,7		Caraway seed	Germany	2003	9455/03	BfR
Sally	41:z:1,6		Beef meat	Senegal	2003	9460/03	IP/IPD
Evry	35:i:z ₆	Tar-	Human stools	France	2003	9462/03	IP
Albertbanjul	44:r:1,5	01-	Meat	Senegal	2003	9475/04	IP/IPD
Martonos	6,14,24:d:1,5		Parsley	Serbia	2004	9485/04	IHU
Gueuletapee	9,12:g,m,s:-		Chicken	Senegal	2004	9489/04	IP
Lamphun	6,8:y:1,2		Animal feed	Thailand	2003	9491/04	TNIH
Parakou	1,42:l,w:z ₃₅		Water	Africa	2004	9495/04	IHU
Hohentwiel	30:z:e,n,x,z ₁₅		Paprika powder	Germany	2004	9497/04	IHU
Carpentras	38:z ₃₅ :e,n,z ₁₅		Seed	France	2004	9500/04	IP
Lund	6,8:l,v:z ₆		Human stools	Sweden	2003	9502/04	SIIDC
Willamette	38:d:1,5	01-	Human stools	USA	2004	9508/04	CDC
Yellowknife	9,12:r:e,n,x		Human	Canada	2004	9523/04	NML
Marsabit	52:l,w:1,5	01-	Camel	Kenya	2004	9527/04	BfR
Dingiri	17:z:1,6		Human blood	Gambia	2004	9529/04	SSI
Myrria	13,23:i:1,7		Human stools	Nigeria	2004	9544/05	NIPH
Eaubonne	18:g,s,t:-		Human stools	France	2004	9552/05	IP
Namur	39:z ₄ ,z ₂₃ :-	01-	Human stools	Belgium	2005	9585/05	IP/ISP
Lonestar	41:c:-	01-	Human stools	USA	2005	9592/05	CDC
Winslow	13,22:z:1,5	Gal+	Wild pig	USA	2005	9593/05	CDC
Salinas	40:a:1,7		Human stools	USA	2005	9596/05	CDC
Picpus	13,23:z ₃₅ :1,6		Human stools	France	2005	9597/05	IP
Ivrysurseine	13,23:z:z ₆		Human stools	France	2005	9598/05	IP
Chennai	4,12:d:z ₃₅ :-		Prawns	New Zealand	2005	9627/06	ESR
Sandaga	3,10:z ₃₈ :1,2		Human stools	Senegal	2006	9647/06	IP/IPD
Umbadah	1,3,19:d:1,2		Bovine	Sudan	2006	9663/06	LFZ
Heistopdenberg	8,20:b:l,w		Human	Belgium	2006	9665/06	IP/ISP
Etobicoke ^a	28:d:z ₆	01-	Human	Canada	2006	9677/07	NML
Penzing ^a	35:k:e,n,z ₁₅	01-	Human	Austria	2005	9697/07	IMED
Portedeslilas ^a	1,42:l,v:1,6,7	Dul-	Human blood	France	2007	9700/07	IP
Neuland ^a	16:z ₃₅ :1,5		Plant environment	Germany	2007	9713/07	IHU
Boston ^a	13,23:c:e,n,z ₁₅		Human stools	USA	2007	9716/07	CDC
Leinster ^a	45:b:1,6		Human	Nigeria	2000	9721/07	NUI
Galway ^a	13,23:k:e,n,z ₁₅		Human	Nigeria	2007	9722/07	NUI
Ulm ^a	1,6,14,25:z ₁₀ :z ₆		Sesame seed	Germany	2007	9743/07	IHU

Darfur ^a	43:z ₄₁ :1,2		Human	Tchad	2007	9748/07	RKI
Miromesnil ^a	1,3,19:z ₄ ,z ₂₃ :-		Human stools	France	2007	9758/07	IP
Serenli ^a	1,13,23:z:1,5		Human stools	Africa	2006	9759/07	NIPH
subsp. <i>salamae</i>							
	48:z ₃₉ :z ₈₁	Gel-, Sal+	Human stools	USA	2003	9505/04	CDC
	6,7:z ₄ ,z ₂₃ :-	01-,ONPG+	Human	Canada	2004	9521/04	NML
	40:m,t:e,n,x	01-	Beef	Namibia	2002	9539/05	NIPH
	40:l,z ₂₈ :e,n,x		Beef	Namibia	2002	9540/05	NIPH
	28:m,t:z ₃₉		Meat	Namibia	2003	9543/05	NIPH
	40:z ₁₀ :e,n,x	ONPG+	Chameleon	Germany	2005	9583/05	BfR
	17:d :- ^a		Beef	Africa	2006	9669/06	NIPH
	60:z ₁₀ :z ₃₉ ^a	Gel-	Human stools	USA	2007	9714/07	CDC
	6,7:z ₃₈ :e,n,x ^a		Human stools	Mozambique	2007	9733/07	NPHI
	48:z ₈₁ :1,5,7 ^{a,b}	Gel-	Fish meal	Angola	1961	9744/07	IP/IHU
	9,46:l,w:e,n,x ^a		Beef	Namibia	2006	9760/07	NIPH
subsp. <i>arizonae</i>							
	48:z ₂₉ :-		Human stools	USA	2002	9379/03	CDC
	45:z ₃₆ :-		Snake	USA	2003	9464/03	CDC
	21:z ₃₆ :-		Human stools	USA	2005	9595/05	CDC
	50:g,z ₅₁ :-	GGT+	Human stools	USA	2005	9628/06	CDC
	18:z ₃₆ :- ^a		Human blood	USA	2006	9715/07	CDC
subsp. <i>diarizonae</i>							
	48:z ₄ ,z ₂₄ :-	Muc+, Glu-	Snake	Switzerland	2002	9407/03	UVB
	8:k:z ₃₅	GGT-, Mal-	Avian	USA	2003	9446/03	CDC
	52:k:e,n,x,z ₁₅		Water	France	2003	9453/03	IP
	63:(k):z		Snake	USA	2003	9488/04	CDC
	43:g,t:-	Muc+, Glu-	Human stools	Sweden	2004	9504/04	SIIDC
	8:r:z	Glu-, Gel-	Human stools	USA	2003	9507/04	CDC
	50:i:z ₅₃	Muc+, Tar+	Chameleon	Germany	2005	9604/05	BfR
	65:i:z	Muc+	Reptile	Germany	2006	9648/06	BfR
subsp. <i>houtenae</i>							
	18:g,z ₅₁ :-		Human	USA	2006	9654/06	CDC
<i>Salmonella bongori</i>							
	1,9,12:d:e,n,x ^a		Cattle	Finland		9736/07	NPHI

1 ^aSerovar name or antigenic formula not recorded in the current (9th) edition of the White-Kauffmann-Le
2 Minor scheme.

3 ^bCorresponds to Kauffmann's strain 1357K, originally described as the reference strain of *S. enterica*
4 subsp. *enterica* serovar Hisingen (48:a:1,5,7).

5 ^cThe differential phenotypical characters of *Salmonella* species and subspecies are indicated in
6 reference 3. Only the atypical results are mentioned. Tests used : β-galactosidase, ONPG ; β-
7 glucuronidase, GLU ; gelatinase, Gel ; galacturonate, Gal ; malonate, Mal ; salicin, Sal ; dulcitol,
8 Dul ; mucate, Muc ; L(+) tartrate (= *d*-tartrate), Tar ; γ-glutamyltransferase, GGT ; lyse by phage O1,
9 O1. +, positive reaction ; -, negative reaction.

10 ^dThe National Reference Centres having sent the isolates are indicated in the acknowledgments section.

1 **Table 2.** New variants of previously described *Salmonella* serovars recognized by the WHO Collaborating Centre for Reference and Research on
 2 *Salmonella*, 2003-2007.

3

IP strain number	Antigenic formula	Other characters ^a	Source	Area of contamination or isolation	Year	Received from ^b	Serovar name	Updated antigenic formula
<i>S. enterica</i> subsp. <i>enterica</i>								
9429/03	43:l,w:z ₄₄	01-	Human	Switzerland	2003	UVB	Epalinges	43:l,w:[z ₄₄]
9445/03	4,12:g,m,s:1,2	Tar-	Turkey	USA	2003	CDC	Hato	<u>1</u> ,4,[5],12:g,m,s:[1,2]
9450/03	{6,7,14}{54}:g,m,s:-		Calf meat	Germany	2003	IHU	Montevideo	{6,7, <u>14</u> }{54}:g,m,[p],s:[1,2,7]
9467/03	1,4,12:i:e,n,z ₁₅		Human stools	France	2003	IP	Tsevie	<u>1</u> ,4,12:i:e,n,z ₁₅
9549/05	43:z ₄ ,z ₂₃ :1,2		Human stools	Norway	2004	NIPH	Farmingdale	43:z ₄ ,z ₂₃ :[1,2]
9554/05	1,4,12:e,h:e,n,z ₁₅		Sunflower kernels	Germany	2004	IHU	Sandiego	<u>1</u> ,4,[5],12:e,h:e,n,z ₁₅
9645/06	1,4,12:r:e,n,z ₁₅		Cattle	Sudan	2006	LFZ	Drogana	<u>1</u> ,4,12,[27]:r,[i]:e,n,z ₁₅
9658/06	1,4,12:r:l,w		Human stools	France	2006	IP	Bochum	<u>1</u> ,4,[5],12:r:l,w
9717/07	4,5,12:b:1,5	Muc-	Human stools	USA	2006	CDC	Limete	<u>1</u> ,4,[5],12:b:1,5 ^c
9740/07	42:l,v:1,6,7	Dul-	Human stools	Finland	2007	NPHI	Portedeslilas	<u>1</u> ,42:l,v:1,6,7 ^c
9742/07	1,13,23:d:l		Human stools	France	2007	IP	Putten	<u>1</u> ,13,23:d:l,w ^c
9752/07	1,4,12,27:l,v:1,5 ^a		Human stools	France	2007	IP	Azteca	<u>1</u> ,4,[5],12,[27]:l,v:1,5 ^c
<i>S. enterica</i> subsp. <i>salamae</i>								
9383/03	4,5,12:b:-		Turtle faeces	Germany	2003	BfR		1,4,[5],12,[27]:b:[e,n,x]
<i>S. enterica</i> subsp. <i>diarizonae</i>								
9469/03	1,40:l,v:z ₅₃		Human	Israel	2003	GCL		<u>1</u> ,40:l,v:z ₅₃
<i>S. enterica</i> subsp. <i>indica</i>								
9437/03	6,14:a:e,n,x	01-	Environment	Switzerland	2003	UVB		[1],6,14,[25]:a:e,n,x

4

5 ^aThe differential phenotypical characters of *Salmonella* species and subspecies are indicated in reference 3. Only the atypical results are mentioned. Tests
 6 used : dulcitol, Dul ; mucate, Muc ; L(+) tartrate (= *d*-tartrate), Tar; lyse by phage O1, O1. +, positive reaction ; -, negative reaction.

7 ^bThe National Reference Centres having sent the isolates are indicated in the acknowledgments section.

8 ^cAntigenic formula not recorded or not updated in the current (9th) edition of the White-Kauffmann-Le Minor scheme.

1 **Table 3.** Present number of serovars in each species and subspecies of *Salmonella*.
 2
 3

4	<i>S. enterica</i>	
5	subsp. <i>enterica</i>	1547
6	subsp. <i>salamae</i>	513
7	subsp. <i>arizonae</i>	100
8	subsp. <i>diarizonae</i>	341
9	subsp. <i>houtenae</i>	73
10	subsp. <i>indica</i>	13
11		
12	<i>S. bongori</i>	23
13		
14	Total	2 610

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